United States
Department of
Agriculture

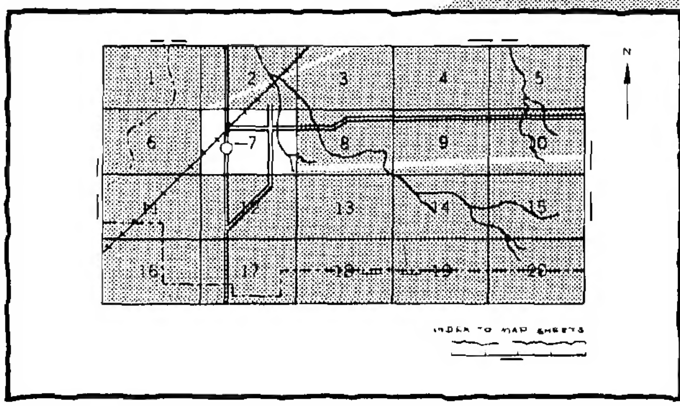
Soil
Conservation
Service

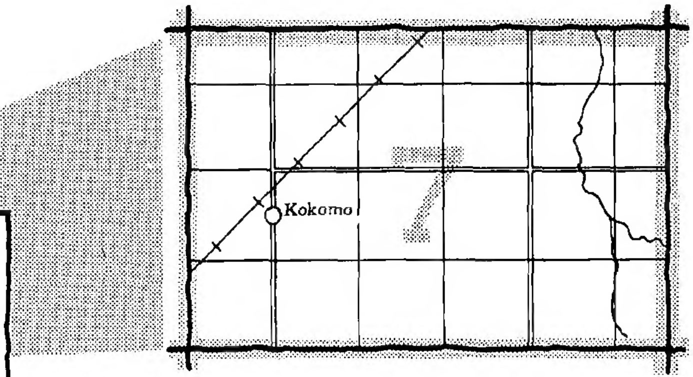
In cooperation with
Kansas Agricultural
Experiment Station

Soil Survey of Ellsworth County, Kansas

HOW TO USE

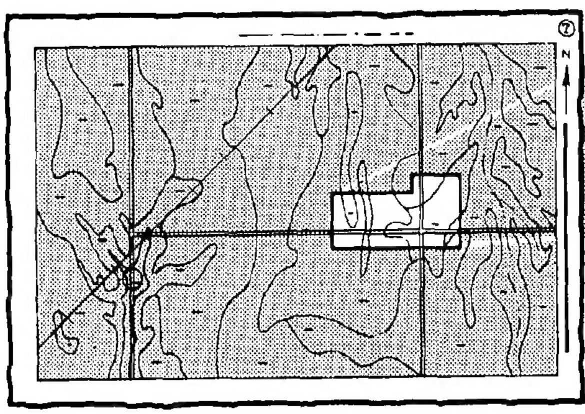
1. Locate your area of interest on the "Index to Map Sheets."

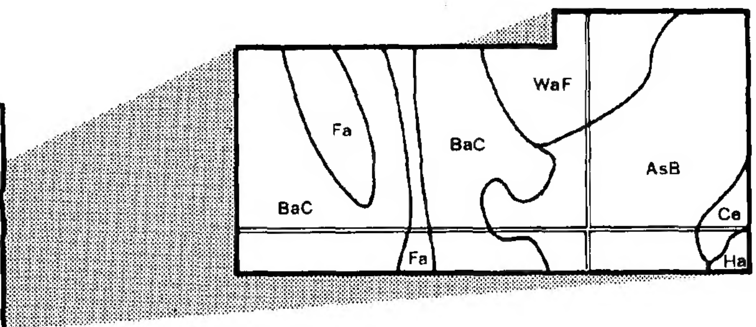




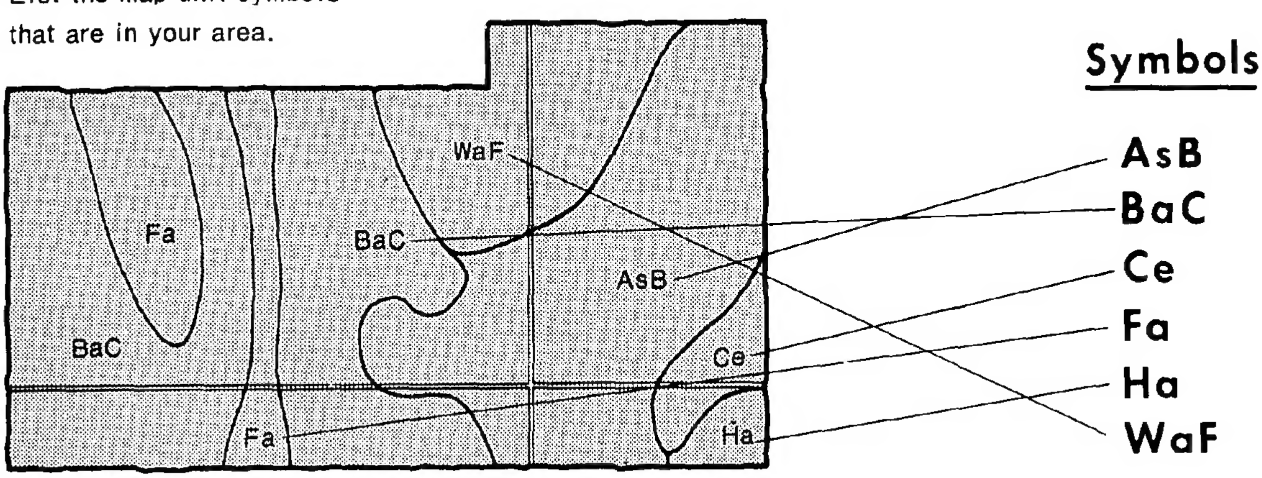
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



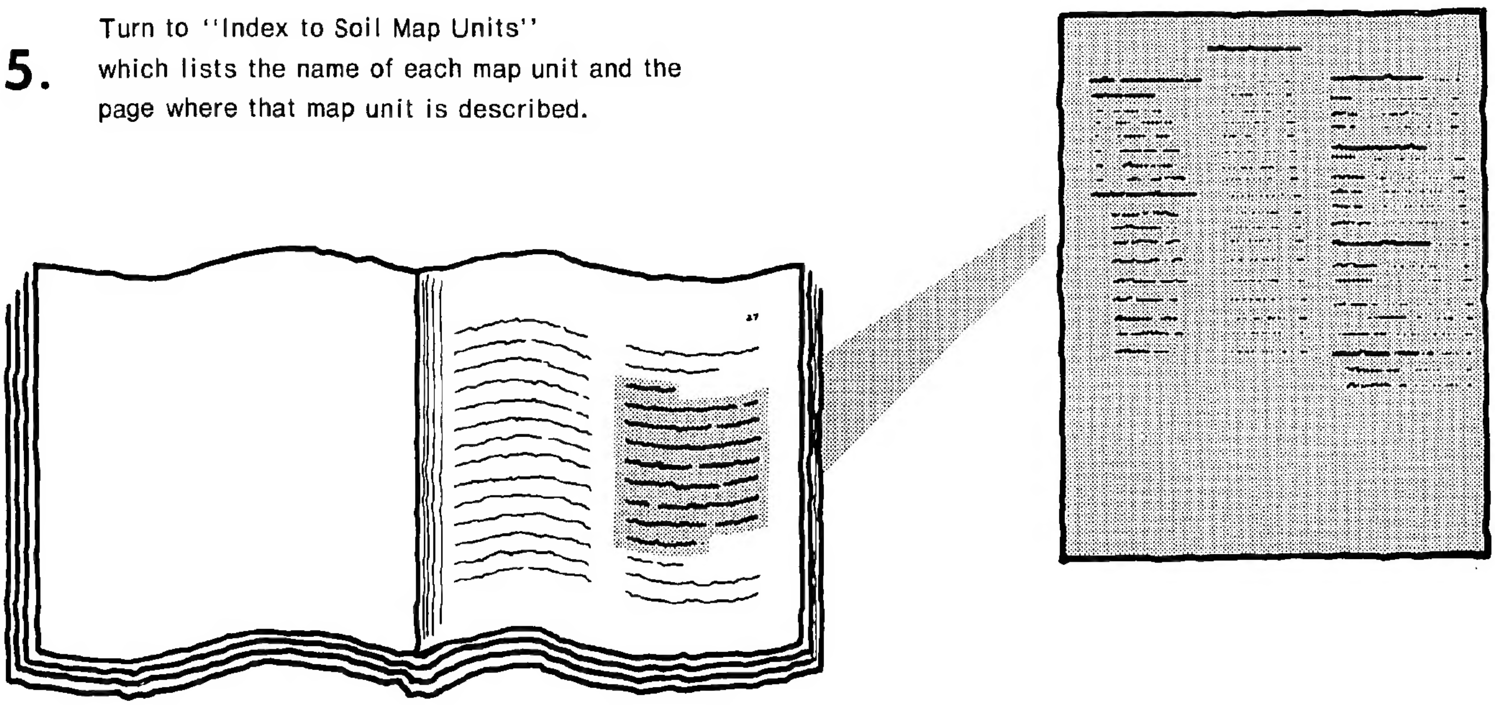


4. List the map unit symbols that are in your area.

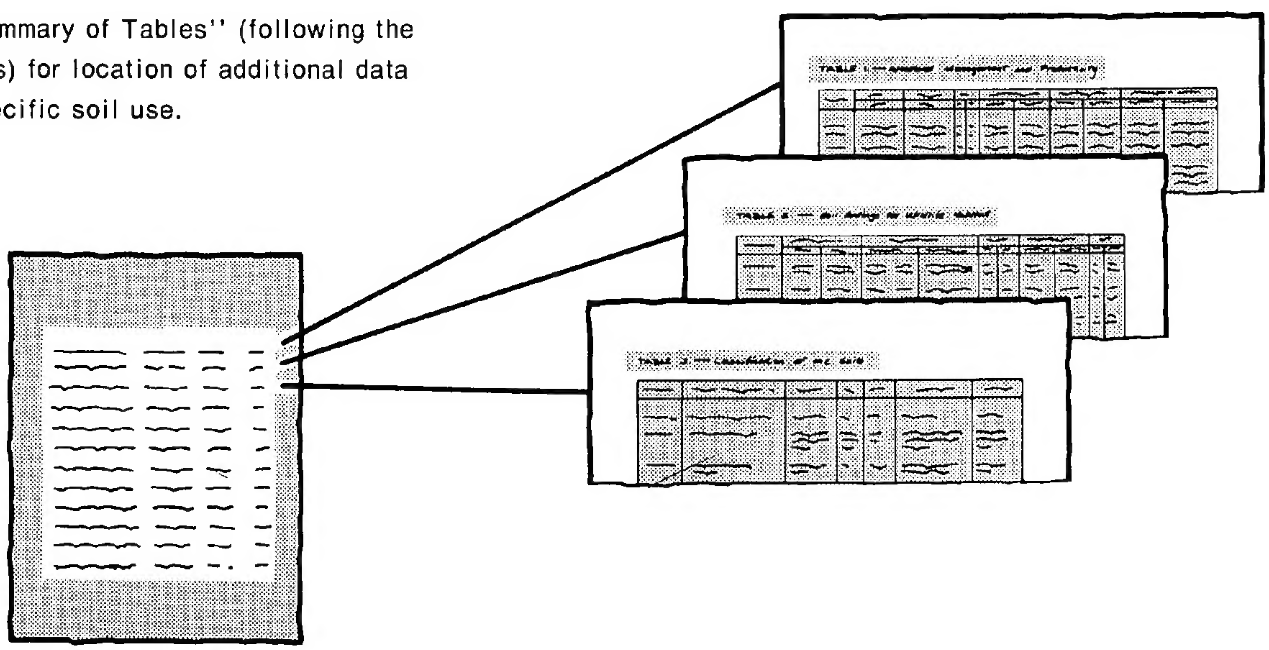


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, handicap, or age.

Major fieldwork for this soil survey was completed in 1984. Soil names and descriptions were approved in 1985. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1985. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Ellsworth County Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: An area of Mushroom Rock State Park. Sandstone concretions on pedestals are prominent features in the park.

Contents

Soil Series

Issued February 1989

Index to Map Units

Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Ellsworth County, Kansas. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

James N. Habiger

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State Conservationist
Soil Conservation Service

Soil Survey of Ellsworth County, Kansas

By Wesley L. Barker and Darold A. Dodge, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
the Kansas Agricultural Experiment Station

ELLSWORTH COUNTY is in central Kansas (fig. 1). It has an area of 462,707 acres, or about 723 square miles. In 1980, it had a population of 6,514. Ellsworth, the county seat and the largest town, had a population of 2,580. The county was organized in 1867.

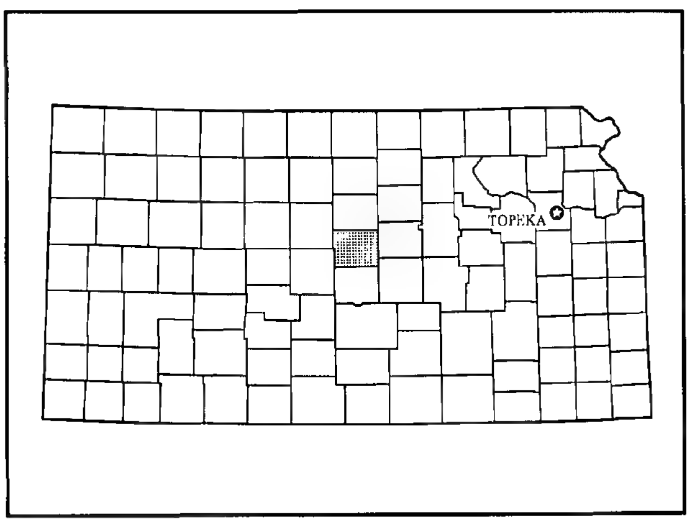

Figure 1.—Location of Ellsworth County in Kansas.

Most of Ellsworth County is in the Central Kansas Sandstone Hills major land resource area. A small area in the northwest corner, however, is on the Rolling Plains and Breaks, and a small area in the southwest corner is on the Central Loess Plains. The soils in the county are generally deep, have a loamy or silty surface layer, and have a loamy, silty, or clayey subsoil. Some soils in the more sloping areas where sandstone crops out are moderately deep or shallow.

The highest elevation in the county is about 1,910 feet above sea level. It is on the divide between the Smoky Hill and Arkansas Rivers, along the Barton-Ellsworth county line. The lowest elevation is about 1,410 feet above sea level, in an area where the Smoky Hill River leaves the county. Most of the county is drained by the Smoky Hill River and its tributaries (fig. 2). The northern edge, however, is drained by the Saline River, and the southwestern part is drained by the Arkansas River.

Farming and ranching are the main enterprises in the county. About 43 percent of the county is used for cultivated crops. Wheat and grain sorghum are the principal crops. The main kind of livestock is cattle.

General Nature of the County

This section gives general information concerning the county. It describes climate and natural resources.

Climate

Prepared by L. Dean Bark, climatologist, Kansas Agricultural Experiment Station, Manhattan, Kansas.

The climate of Ellsworth County is typical continental, as can be expected of a location in the interior of a large landmass in the middle latitudes. It is characterized by large daily and annual variations in temperature. Winters are cold because of frequent outbreaks of polar air. The cold temperatures prevail only from December to February. Warm summer temperatures prevail for about 6 months every year. They provide a long growing season for the crops grown in the county. Spring and fall are relatively short.

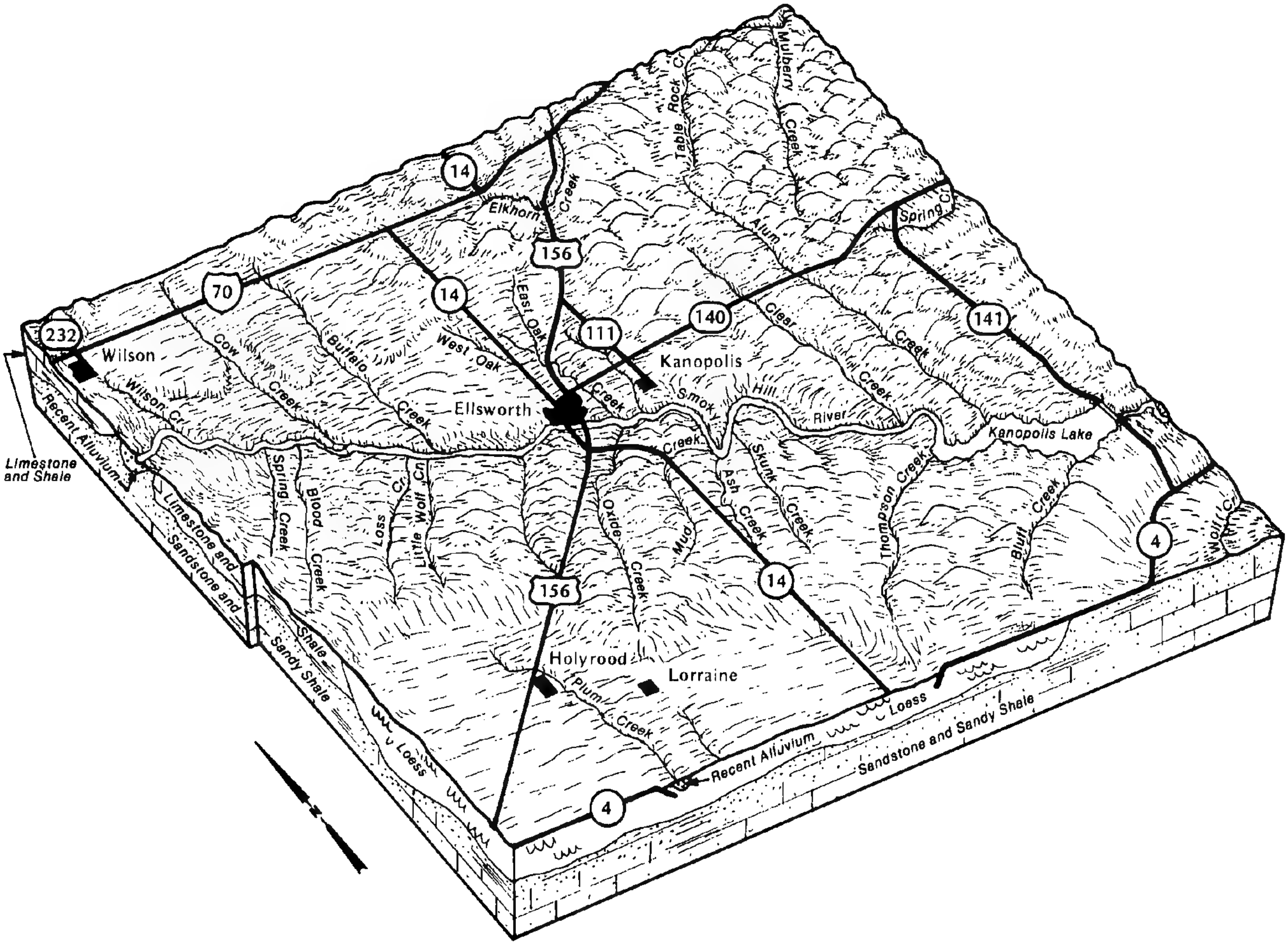

Figure 2.—Drainage pattern, parent material, and relief in Ellsworth County.

Ellsworth County is generally along the western edge of the flow of moisture-laden air from the Gulf of Mexico. Shifts in this current result in a rather large range in the amount of precipitation received. Precipitation is heaviest from May through September, when much of it falls during late-evening or nighttime thunderstorms. Precipitation in dry years is marginal for agricultural production. Even in wet years, crops commonly are adversely affected by prolonged periods without rain.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Ellsworth in the period 1941 to 1970. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 32.4 degrees F, and the average daily minimum temperature is 20.1 degrees. The lowest temperature on record, which occurred at Ellsworth on January 18, 1913, is -30 degrees. In summer the average temperature is 78.4 degrees, and the average daily maximum temperature is 91.3 degrees. The highest recorded temperature, which occurred at Ellsworth on August 12, 1938, is 117 degrees.

The total annual precipitation is 28.09 inches. Of this, 20.81 inches, or 74 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 15.35 inches. The heaviest 1-day rainfall during the period of record was 5.98 inches at Kanopolis Dam on October 19, 1941.

Severe windstorms and tornadoes accompany well developed thunderstorms, but they are infrequent and of

local extent. Losses from hail are more severe, but they are not so great as the losses in counties to the west of this county.

The average seasonal snowfall is 23.5 inches. The highest recorded seasonal snowfall is 59 inches. On the average, 20 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The sun shines 76 percent of the time possible in summer and 64 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 13.4 miles per hour, in April. Average annual windspeed is 11.4 miles per hour.

Natural Resources

Soil is the most important natural resource in the county. It provides a growing medium for range plants and field crops.

Other natural resources include water, limestone, sand and gravel, clay, oil, and salt. The water supply comes from surface impoundments, streams, and some springs and wells. Limestone has been quarried for fenceposts, houses, and road construction, mostly in the western part of the county. Sand and gravel pits are on high stream terraces along the Smoky Hill River. Clay from the Dakota Formation is used in the manufacture of bricks. Oil is produced mostly in the western and southern parts of the county. Salt is mined near Kanopolis.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management were assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will

always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

Map Unit Descriptions

This section describes the map units in the survey area at two levels of detail. The general soil map units, called soil associations, are described first and then the detailed map units. Most of the general soil map units represent the soils of major extent in the survey area. The detailed map units represent all of the named soils in the survey area.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

The descriptions and names of the soils identified on the general soil map of this county do not fully agree with those of the soils identified on the maps of adjacent counties. Differences result from a better knowledge of soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

1. Harney-Armo Association

Deep, gently sloping to strongly sloping, well drained soils that have a loamy, silty, or clayey subsoil; on uplands

This association is on ridgetops, side slopes, and foot slopes that are drained by intermittent streams. In some areas it is cut by deeply entrenched drainageways. Slopes range from 1 to 15 percent.

This association makes up about 13 percent of the county. It is about 42 percent Harney soils, 38 percent Armo soils, and 20 percent minor soils (fig. 3).

The gently sloping and moderately sloping Harney soils formed in loess on narrow ridgetops and side slopes. Typically, the surface layer is dark grayish brown silt loam about 9 inches thick. The subsurface layer also is dark grayish brown silt loam. It is about 5 inches thick. The subsoil is about 26 inches thick. The upper part is brown, very firm silty clay, and the lower part is pale brown, firm silty clay loam. The substratum to a depth of about 60 inches is pale brown silt loam.

The moderately sloping and strongly sloping Armo soils formed in loamy colluvium weathered from chalky limestone. They are on foot slopes. Typically, the surface layer is dark grayish brown, calcareous loam about 9 inches thick. The subsurface layer is grayish brown, calcareous loam about 6 inches thick. The subsoil is pale brown, calcareous, friable clay loam about 15 inches thick. The substratum to a depth of about 60 inches is very pale brown, calcareous gravelly clay loam.

The minor soils in this association are the Hord, Nibson, Roxbury, and Wakeen soils. Hord soils are on stream terraces. The shallow, somewhat excessively drained Nibson soils are on side slopes. Roxbury soils are on narrow flood plains. The moderately deep Wakeen soils are on ridgetops and the upper side slopes.

About 60 percent of this association is used for cultivated crops. The rest is used dominantly as range. Wheat, grain sorghum, and forage sorghum are the chief crops. Controlling water erosion, conserving moisture, and maintaining tilth and fertility are the main concerns in managing the cultivated areas. Maintaining the growth and vigor of desirable grasses is the main concern in managing range.

2. Lancaster-Hedville-Harney Association

Deep to shallow, gently sloping to steep, well drained and somewhat excessively drained soils that have a loamy, silty, or clayey subsoil; on uplands

This association is on narrow ridgetops and side slopes. It is drained by many intermittent drainageways and a few small creeks. Some areas have deeply entrenched valleys. Shale and sandstone outcrops are common on the steeper slopes. Slopes range from 1 to 40 percent.

This association makes up about 48 percent of the county. It is about 40 percent Lancaster soils, 17 percent Hedville soils, 16 percent Harney soils, and 27 percent minor soils (fig. 4).

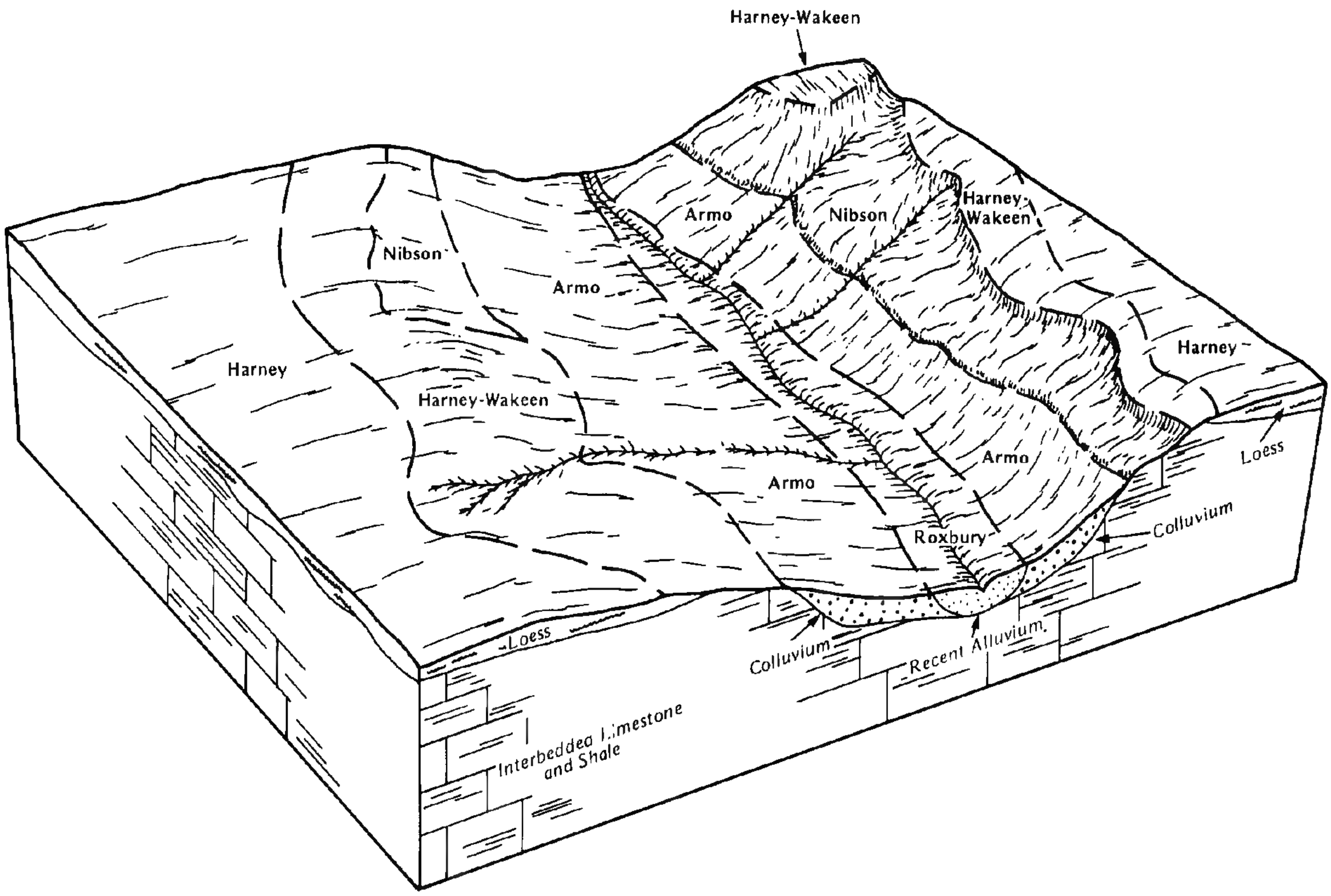

Figure 3.—Pattern of soils and parent material in the Harney-Armo association.

The moderately deep, moderately sloping and strongly sloping, well drained Lancaster soils formed in material weathered from noncalcareous sandstone and sandy shale on smooth ridgetops and side slopes. Typically, the surface layer is dark grayish brown loam about 8 inches thick. The subsurface layer is brown loam about 8 inches thick. The subsoil is brown, firm sandy clay loam about 16 inches thick. Weathered, sandy shale is at a depth of about 32 inches.

The shallow, moderately sloping to steep, somewhat excessively drained Hedville soils formed in material weathered from noncalcareous sandstone on narrow ridgetops and sharp slope breaks. Typically, the surface layer is dark grayish brown loam about 7 inches thick. The subsoil is brown, very friable channery loam about 9 inches thick. Sandstone is at a depth of about 16 inches.

The deep, gently sloping and moderately sloping, well drained Harney soils formed in loess on narrow ridgetops and side slopes. Typically, the surface layer is dark grayish brown silty clay loam about 5 inches thick. The subsoil is about 35 inches thick. The upper part is dark grayish brown, firm silty clay, and the lower part is pale brown, friable silty clay loam. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam.

The minor soils in this association are the Edalgo, Tobin, and Wells soils. The moderately deep Edalgo soils are on ridgetops and side slopes. The occasionally flooded Tobin soils are on flood plains along drainageways. The deep Wells soils are on side slopes.

This association is used mainly as range. Maintaining the growth and vigor of desirable grasses is the main concern in managing range.

3. Crete-Harney Association

Deep, nearly level to moderately sloping, moderately well drained and well drained soils that have a silty or clayey subsoil; on uplands

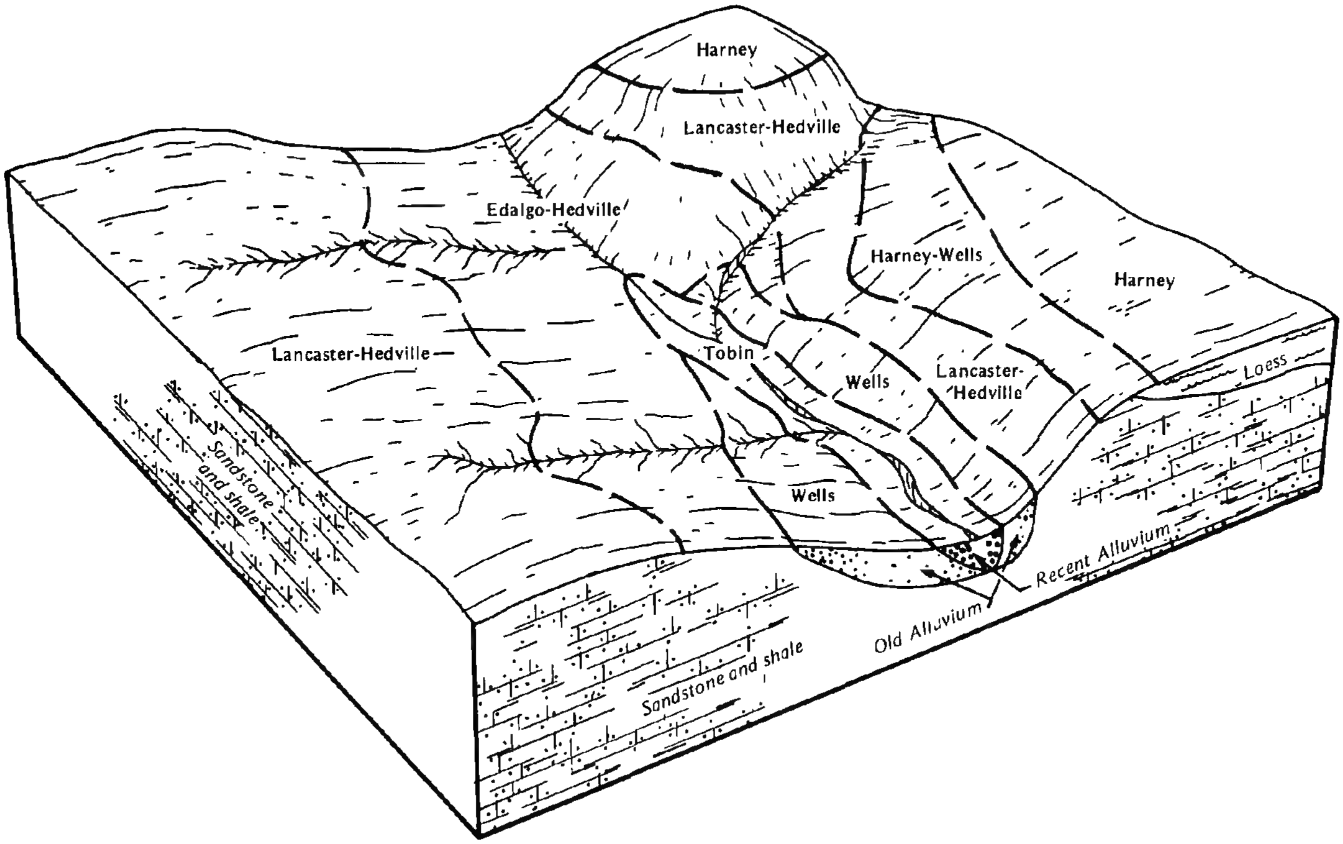

Figure 4.—Pattern of soils and parent material in the Lancaster-Hedville-Harney association.

This association is on flats, ridgetops, and side slopes dissected by a few intermittent streams. Slopes range from 0 to 6 percent.

This association makes up about 27 percent of the county. It is about 42 percent Crete soils, 41 percent Harney soils, and 17 percent minor soils (fig. 5).

The nearly level, moderately well drained Crete soils formed in loess on flats and broad, smooth ridgetops. Typically, the surface layer is grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown silty clay loam about 7 inches thick. The subsoil is about 28 inches thick. It is dark grayish brown, very firm silty clay in the upper part; brown, very firm silty clay in the next part; and brown, firm silty clay loam in the lower part. The substratum to a depth of about 60 inches is pale brown, mottled silty clay loam.

The gently sloping and moderately sloping, well drained Harney soils formed in loess on narrow ridgetops and side slopes. Typically, the surface layer is dark grayish brown silt loam about 9 inches thick. The subsurface layer also is dark grayish brown silt loam. It is about 5 inches thick. The subsoil is about 26 inches thick. The upper part is brown, very firm silty clay, and the lower part is pale brown, firm silty clay loam. The substratum to a depth of about 60 inches is pale brown silt loam.

The minor soils in this association are the Geary, Nibson, Roxbury, Tobin, and Wakeen soils. Geary soils have less clay in the subsoil than the Crete and Harney soils. The shallow Nibson soils and the moderately deep Wakeen soils are on side slopes along drainageways. The rarely flooded or occasionally flooded Roxbury soils and the occasionally flooded Tobin soils are on narrow flood plains.

Nearly all of this association is used for cultivated crops. Wheat, grain sorghum, and forage sorghum are the chief crops. Controlling water erosion, conserving moisture, and maintaining tilth and fertility are the main concerns in managing the cultivated areas.

4. Wells-Meadin Association

Deep, gently sloping to strongly sloping, well drained and excessively drained soils that have a loamy subsoil; on uplands

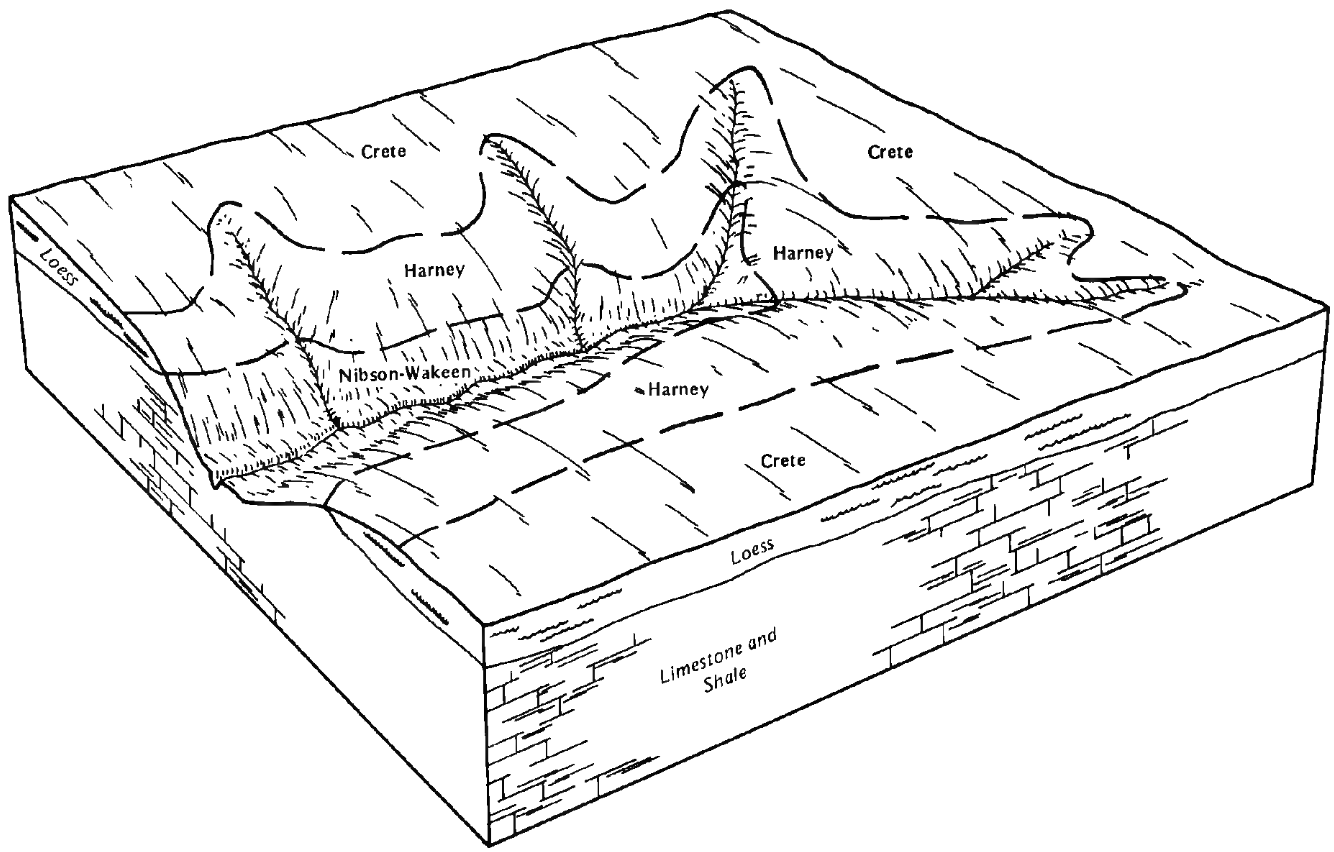

Figure 5.—Pattern of soils and parent material in the Crete-Harney association.

This association is on narrow ridgetops and side slopes along the Smoky Hill River. Slopes range from 1 to 15 percent.

This association makes up about 7 percent of the county. It is about 50 percent Wells soils, 20 percent Meadin soils, and 30 percent minor soils.

The gently sloping and moderately sloping, well drained Wells soils formed in material weathered from noncalcareous sandstone and in old alluvium derived from sandstone and sandy shale. They are on ridgetops and the upper side slopes. Typically, the surface layer is dark grayish brown loam about 11 inches thick. The subsoil is firm sandy clay loam about 33 inches thick. The upper part is brown, and the lower part is yellowish red. The substratum to a depth of about 60 inches is reddish yellow sandy loam.

The moderately sloping and strongly sloping, excessively drained Meadin soils formed in loamy and sandy material on ridgetops and side slopes. Typically, the surface layer is dark grayish brown sandy loam about 7 inches thick. The next layer is dark grayish brown, very friable gravelly sandy loam about 7 inches thick. The substratum to a depth of about 60 inches is very pale brown gravelly coarse sand.

The minor soils in this association are the Crete, Harney, Jansen, and Tobin soils. The silty, nearly level Crete soils are on flats. The silty, gently sloping and moderately sloping Harney soils are on side slopes. The gently sloping Jansen soils are on the lower side slopes. They are moderately permeable in the upper part and very rapidly permeable in the lower part. The occasionally flooded Tobin soils are on narrow flood plains along intermittent streams.

About 60 percent of this association is used for cultivated crops. The rest is used dominantly as range. Controlling water erosion, conserving moisture, and maintaining tilth and fertility are the main concerns in managing the cultivated areas. Maintaining the growth and vigor of desirable grasses is the main concern in managing range.

5. McCook-Roxbury Association

Deep, nearly level, well drained soils that have a loamy or silty subsoil; on stream terraces and flood plains

This association is on stream terraces and flood plains along the Smoky Hill River. The soils are subject to flooding. Slopes generally are 0 to 2 percent, but they are steeper in some areas along the stream channels.

This association makes up about 5 percent of the county. It is about 36 percent McCook soils, 30 percent Roxbury soils, and 34 percent minor soils.

The McCook soils formed in calcareous, stratified, silty and loamy alluvium. Typically, the surface layer is grayish brown, calcareous silt loam about 6 inches thick. The subsurface layer also is grayish brown, calcareous silt loam about 6 inches thick. The next layer is light brownish gray, calcareous, friable silt loam about 10 inches thick. The upper part of the substratum is light brownish gray, calcareous silt loam that has a few thin strata of more sandy material. The lower part to a depth of about 60 inches is light gray, calcareous silt loam.

The Roxbury soils formed in calcareous, silty alluvium. Typically, the surface layer is dark grayish brown, calcareous silt loam about 20 inches thick. The subsurface layer also is dark grayish brown, calcareous silt loam. It is about 12 inches thick. The substratum to a depth of 60 inches is grayish brown and light brownish gray, calcareous silt loam.

The minor soils in this association are the Cass and Hord soils. The loamy Cass soils are along the streams that drain the more sandy areas. The rarely flooded Hord soils are on high stream terraces.

This association is used mainly for cultivated crops. The chief crops are wheat, grain sorghum, and alfalfa. Conserving moisture and maintaining tilth and fertility are the main concerns in managing the cultivated areas. Flooding is a hazard in some years.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Harney silt loam, 1 to 3 percent slopes, is a phase of the Harney series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Harney-Wells complex, 2 to 6 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

The descriptions and names of the soils identified on the detailed soil maps of this county do not fully agree with those of the soils identified on the maps of adjacent counties. Differences result from a better knowledge of soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the counties.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Ar—Armo loam, 3 to 7 percent slopes. This deep, moderately sloping, well drained soil is on foot slopes below limestone hills. Individual areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the surface layer is dark grayish brown, calcareous loam about 9 inches thick. The subsurface layer is grayish brown, calcareous loam about 8 inches thick. The subsoil is pale brown, calcareous, friable clay loam about 15 inches thick. The substratum to a depth of about 60 inches is very pale brown, calcareous gravelly clay loam. In some cultivated areas erosion has exposed the lighter colored subsoil. In places the soil is more sandy throughout.

Included with this soil in mapping are small areas of Harney and Wakeen soils. The silty Harney soils are on narrow ridgetops and the upper side slopes. The

moderately deep Wakeen soils are on side slopes. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Armo soil, and available water capacity is high. Surface runoff and natural fertility are medium. The surface layer is moderately alkaline and friable, and tilth is good.

Most areas are used for cultivated crops. A few are used as range. This soil is moderately well suited to wheat, grain sorghum, and alfalfa. Grain sorghum is affected by chlorosis because the soil has a high content of lime. Water erosion is a hazard if cultivated crops are grown. Contour farming, terraces, grassed waterways, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the rate of water infiltration.

The native vegetation on this soil is dominantly big bluestem, little bluestem, and sideoats grama. In areas that are continually overgrazed, these grasses are replaced by less productive plants, such as tall dropseed, Baldwin ironweed, and western ragweed. Water erosion is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a scheduled deferment of grazing during the growing season, and a uniform distribution of grazing helps to keep the range in a productive condition.

The areas between cropland and range provide good habitat for upland wildlife, such as pheasants and quail. The habitat can be improved by planting trees or shrubs or by leaving crops unharvested in small areas between the cropland and the range.

This soil is well suited to dwellings and septic tank absorption fields. It is only moderately well suited to sewage lagoons because of seepage and slope. Seepage can be controlled by sealing the lagoon. If the less sloping areas are selected as sites for lagoons, less leveling and banking will be needed during construction.

The land capability classification is IIIe, and the range site is Limy Upland.

Au—Armo loam, 7 to 15 percent slopes. This deep, strongly sloping, well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is dark grayish brown, calcareous loam about 9 inches thick. The subsurface layer is grayish brown, calcareous loam about 6 inches thick. The subsoil is pale brown, calcareous, friable clay loam about 15 inches thick. The substratum to a depth of about 60 inches is very pale brown, calcareous gravelly clay loam. In some places the surface soil is more clayey. In other places the soil is more sandy throughout.

Included with this soil in mapping are small areas of Harney, Nibson, and Roxbury soils. The silty Harney soils are on narrow ridgetops and the upper side slopes. The shallow Nibson soils are on the upper side slopes. The silty Roxbury soils are on flood plains along narrow drainageways. Included soils make up about 15 percent of the unit.

Permeability is moderate in the Armo soil, and surface runoff is rapid. Available water capacity is high. Natural fertility is medium. The surface layer is moderately alkaline.

Nearly all of the acreage is used as range. Because of a severe hazard of water erosion, this soil is generally unsuited to cultivated crops. It is better suited to range. The native vegetation is dominantly big bluestem, little bluestem, and sideoats grama. In areas that are continually overgrazed, these grasses are replaced by less productive plants, such as tall dropseed, Baldwin ironweed, and western ragweed. Water erosion is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a uniform distribution of grazing, and a scheduled deferment of grazing during the growing season helps to keep the range in a productive condition.

This soil is moderately well suited to dwellings and septic tank absorption fields. It is poorly suited to sewage lagoons. The slope is a limitation affecting all of these uses. Also, seepage is a limitation on sites for sewage lagoons. Buildings should be designed so that they conform to the natural slope of the land. Land shaping is necessary in some areas. Land shaping and installing the distribution lines on the contour help to ensure that septic tank absorption fields function properly. If the less sloping areas are selected as sites for sewage lagoons, less leveling and banking will be needed during construction. Seepage can be controlled by sealing the lagoon.

The land capability classification is VIe, and the range site is Limy Upland.

Cb—Cass fine sandy loam. This deep, nearly level, well drained soil is on flood plains. It is occasionally flooded. Individual areas are long and narrow and range from 10 to 60 acres in size.

Typically, the surface layer is grayish brown fine sandy loam about 7 inches thick. The subsurface layer also is grayish brown fine sandy loam. It is about 6 inches thick. The next layer is brown, friable fine sandy loam about 5 inches thick. The upper part of the substratum is brown fine sandy loam. The lower part to a depth of about 60 inches is very pale brown loamy fine sand. In places the surface soil is more than 20 inches thick.

Included with this soil in mapping are small areas of the silty Tobin soils. These soils are in the slightly lower landscape positions or in positions similar to those of the Cass soil. They make up about 5 percent of the unit. Also included are frequently flooded areas in narrow

meandering stream channels. These areas make up 2 to 5 percent of the unit.

Permeability is moderately rapid in the Cass soil, and surface runoff is slow. Available water capacity is moderate. Natural fertility is high. The surface layer is neutral and very friable, and tilth is good.

Nearly all of the acreage is used for cultivated crops. This soil is well suited to wheat, grain sorghum, and alfalfa. Flooding and soil blowing are hazards if cultivated crops are grown. Flooding delays harvesting and planting and damages crops in some years, but in other years the extra moisture may increase crop yields. Overcoming the flooding hazard is difficult without major flood-control measures. Cropping systems that include grasses or legumes and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the rate of water infiltration.

This soil is unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is IIw, and the range site is Sandy Lowland.

Cd—Crete silt loam, 0 to 2 percent slopes. This deep, nearly level, moderately well drained soil is on broad flats in the uplands. Individual areas are irregular in shape and range from 80 to 2,000 acres in size.

Typically, the surface layer is grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown silty clay loam about 7 inches thick. The subsoil is about 28 inches thick. It is dark grayish brown, very firm silty clay in the upper part; brown, very firm silty clay in the next part; and brown, firm silty clay loam in the lower part. The substratum to a depth of about 60 inches is pale brown, mottled silty clay loam. In some places, the subsurface layer is silty clay and the upper part of the subsoil is clay. In other places the subsoil is pale brown.

Permeability and surface runoff are slow. Available water capacity and natural fertility are high. The surface layer is slightly acid and friable, and tilth is good. The shrink-swell potential is high in the subsoil.

Nearly all of the acreage is used for cultivated crops. This soil is well suited to wheat, grain sorghum, forage sorghum, and alfalfa. The clayey subsoil, however, restricts the movement of water and air and the growth of roots and releases water slowly to plants. Returning crop residue to the soil and adding other organic material improve fertility and tilth and increase the rate of water infiltration.

This soil is poorly suited to dwellings and septic tank absorption fields. It is moderately well suited to sewage lagoons. The shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling. The slow permeability restricts the absorption of effluent in septic tank absorption fields. It can be overcome by enlarging the field or by installing the lateral lines below the subsoil. Seepage is a limitation on sites for sewage lagoons. It can be controlled by sealing the lagoon.

The land capability classification is IIs, and the range site is Clay Upland.

Ed—Edalgo loam, 3 to 7 percent slopes. This moderately deep, moderately sloping, well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 50 to 400 acres in size.

Typically, the surface layer is dark grayish brown loam about 8 inches thick. The subsoil is about 15 inches thick. It is reddish brown. The upper part is firm clay loam, and the lower part is very firm clay. The substratum is pink, red, and reddish brown, very firm clay about 11 inches thick. Clayey shale is at a depth of about 34 inches. In some places the depth to clayey shale is more than 40 inches. In other places it is 4 to 20 inches. The surface layer is reddish brown clay loam or silty clay loam in areas where it has been mixed with the upper part of the subsoil by tillage.

Included with this soil in mapping are small areas of Harney, Lancaster, and Wells soil and soils that are affected by sodium. The deep Harney soils are on ridgetops and the upper side slopes. Lancaster soils have less clay in the subsoil than the Edalgo soil. They are in positions on the landscape similar to those of the Edalgo soil. The deep Wells soils are on the upper side slopes. The soils affected by sodium are on narrow ridges. Included soils make up about 20 percent of the unit.

Permeability is very slow in the Edalgo soil, and available water capacity is low. Natural fertility and surface runoff are medium. The surface layer is medium acid and friable, and tilth is good. Root penetration is restricted by the clayey shale at a depth of 20 to 40 inches. The shrink-swell potential is high in the subsoil.

About half of the acreage is used for cultivated crops, is abandoned cropland, or has been reseeded to grass. The rest is used as range. This soil is poorly suited to wheat and grain sorghum and is unsuited to alfalfa. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve fertility and tilth and increase the rate of water infiltration.

This soil is suited to range. The native vegetation is dominantly big bluestem, little bluestem, indiangrass, and sideoats grama. In areas that are continually overgrazed,

these grasses are replaced by less productive plants, such as blue grama, tall dropseed, buffalograss, and western ragweed. Water erosion is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Seeding is needed to improve the productivity of abandoned cropland and other areas that do not have an adequate natural seed source. Grazing management that includes a proper stocking rate, a uniform distribution of grazing, and a scheduled deferment of grazing during the growing season helps to keep the range in a productive condition.

This soil is poorly suited to dwellings and sewage lagoons. It is generally unsuited to septic tank absorption fields because the very slow permeability restricts the absorption of effluent. The shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling. On some sites wetness and soil slippage are problems. Grading helps to remove runoff from the site and lessens the hazard of soil slippage. The moderate depth to bedrock is a limitation on sites for sewage lagoons. The deeper soils on the lower side slopes are better sites for lagoons.

The land capability classification is IVe, and the range site is Clay Upland.

Eh—Edalgo-Hedville loams, 7 to 15 percent slopes. These strongly sloping soils are on side slopes and narrow ridgetops in the uplands. Most areas are dissected by deeply entrenched drainageways. Some have sandstone rocks on the surface. The rocks are 0.5 foot to 4.0 feet in diameter and cover less than 1 percent of the surface. The moderately deep, well drained Edalgo soil is generally on side slopes below the Hedville soil. The shallow, somewhat excessively drained Hedville soil is on the upper side slopes. Individual areas are irregular in shape and range from 20 to 1,000 acres in size. They are about 40 percent Edalgo soil and 30 percent Hedville soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is impractical.

Typically, the Edalgo soil has a surface layer of dark grayish brown loam about 8 inches thick. The subsoil is about 15 inches thick. It is reddish brown. The upper part is firm clay loam, and the lower part is very firm clay. The substratum is pink, red, and reddish brown, very firm clay about 11 inches thick. Clayey shale is at a depth of about 34 inches. In places the depth to clayey shale is less than 20 inches.

Typically, the Hedville soil has a surface layer of dark grayish brown loam about 7 inches thick. The subsoil is brown, very friable channery loam about 9 inches thick. Sandstone is at a depth of about 16 inches. In places the soil is more sandy and is more than 40 inches deep over sandstone.

Included with these soils in mapping are small areas of Lancaster and Wells soils and outcrops of sandstone and shale. Lancaster soils have less clay in the subsoil than the Edalgo soil and more clay in the subsoil than the Hedville soil. They are on side slopes above the Hedville soil. The deep Wells soils are on the lower side slopes. The sandstone rock outcrops are on steep slopes near areas of the Hedville soil. The shale outcrops are on moderately steep and steep slopes near areas of the Edalgo soil. Included areas make up about 30 percent of the unit.

Permeability is very slow in the Edalgo soil and moderate in the Hedville soil. Surface runoff is rapid on both soils. Available water capacity is low in the Edalgo soil and very low in the Hedville soil. Natural fertility is medium in both soils. The surface layer of the Edalgo soil is medium acid, and that of the Hedville soil is slightly acid. Root development is restricted by the bedrock at a depth of 20 to 40 inches in the Edalgo soil and 4 to 20 inches in the Hedville soil. The shrink-swell potential is high in the subsoil of the Edalgo soil.

Nearly all areas are used as range. Because of a severe hazard of water erosion, these soils are generally unsuited to cultivated crops. They are better suited to range. The native vegetation is dominantly little bluestem, big bluestem, switchgrass, and sideoats grama. In areas that are continually overgrazed, these grasses are replaced by less productive plants, such as blue grama, tall dropseed, Baldwin ironweed, and western ragweed. Some overgrazed areas are being invaded by brush. Brush control can improve forage production in these areas. Water erosion is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Well distributed watering and salting facilities and properly located fences improve the distribution of grazing. A proper stocking rate, a uniform distribution of grazing, a scheduled deferment of grazing during the growing season, and timely burning help to keep the range in a productive condition.

Greater prairie chickens inhabit the areas of native grass. Properly managed range provides a good habitat for this wildlife species.

These soils are generally unsuited to building site development because of the slope and the limited depth to bedrock.

The land capability classification is VIe. The Edalgo soil is in the Clay Upland range site, and the Hedville soil is in the Shallow Sandstone range site.

Ev—Edalgo-Hedville loams, 15 to 40 percent slopes. These moderately steep and steep soils are on side slopes and narrow ridgetops in the uplands. Most areas are dissected by deeply entrenched drainageways. Some have sandstone rocks on the surface. The rocks are 0.5 foot to 4.0 feet in diameter and cover less than 1 percent of the surface. The moderately deep, well drained Edalgo soil is generally on side slopes below the

Hedville soil. The shallow, somewhat excessively drained Hedville soil is on the upper side slopes. Individual areas are irregular in shape and range from 10 to 80 acres in size. They are about 40 percent Edalgo soil and 30 percent Hedville soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is impractical.

Typically, the Edalgo soil has a surface layer of grayish brown loam about 8 inches thick. The subsoil is about 15 inches thick. It is reddish brown. The upper part is firm clay loam, and the lower part is very firm clay. The substratum is pink, red, and reddish brown, very firm clay about 11 inches thick. Clayey shale is at a depth of about 34 inches. In places the depth to clayey shale is less than 10 inches.

Typically, the Hedville soil has a surface layer of dark grayish brown loam about 7 inches thick. The subsoil is brown, very friable channery loam about 9 inches thick. Sandstone is at a depth of about 16 inches. In some places the depth to sandstone is less than 5 inches. In other places the soil is more sandy.

Included with these soils in mapping are small areas of Lancaster, Tobin, and Wells soils and small areas of sandstone outcrops. Lancaster soils have less clay in the subsoil than the Edalgo soil and more clay in the subsoil than the Hedville soil. They are on narrow ridgetops and the upper side slopes. The occasionally flooded Tobin soils are on narrow flood plains. The deep Wells soils are on the lower side slopes. The sandstone outcrops are on the steeper slopes near areas of the Hedville soil. Included areas make up about 30 percent of the unit.

Permeability is very slow in the Edalgo soil and moderate in the Hedville soil. Surface runoff is very rapid on both soils. Available water capacity is low in the Edalgo soil and very low in the Hedville soil. Natural fertility is medium in both soils. The surface layer of the Edalgo soil is medium acid, and that of the Hedville soil is slightly acid. Root development is restricted by the bedrock at a depth of 20 to 40 inches in the Edalgo soil and 4 to 20 inches in the Hedville soil. The shrink-swell potential is high in the subsoil of the Edalgo soil.

Nearly all areas are used as range. Because of a severe hazard of water erosion, these soils are generally unsuited to cultivated crops. They are better suited to range. The native vegetation is dominantly big bluestem, little bluestem, switchgrass, indiangrass, and sideoats grama. In areas that are continually overgrazed, these grasses are replaced by less productive plants, such as tall dropseed, blue grama, Baldwin ironweed, and western ragweed. Water erosion is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a uniform distribution of grazing, and a scheduled deferment of grazing during the growing season helps to keep the range in a productive condition.

These soils are generally unsuited to building site development because of the slope and the limited depth to bedrock.

The land capability classification is VIIe. The Edalgo soil is in the Clay Upland range site, and the Hedville soil is in the Shallow Sandstone range site.

Gb—Geary silt loam, 1 to 3 percent slopes. This deep, gently sloping, well drained soil is on ridgetops and side slopes in the uplands. Individual areas are irregular in shape and range from 20 to 200 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 6 inches thick. The subsurface layer also is dark grayish brown silt loam. It is about 7 inches thick. The subsoil is firm silty clay loam about 35 inches thick. It is brown in the upper part and light brown in the lower part. The substratum to a depth of about 60 inches is light brown, calcareous clay loam. In places the surface layer is loam or fine sandy loam. In areas where the upper part of the subsoil has been mixed with the surface soil by tillage, the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Armo and Harney soils. The calcareous Armo soils are on the lower side slopes. Harney soils have more clay in the subsoil than the Geary soil. They are on the higher ridgetops and side slopes. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Geary soil, and surface runoff is medium. Available water capacity and natural fertility are high. The surface layer is medium acid and friable, and tilth is good. The shrink-swell potential is moderate in the subsoil.

Nearly all of the acreage is used for cultivated crops. This soil is well suited to wheat, grain sorghum, and alfalfa. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the rate of water infiltration.

This soil is moderately well suited to dwellings, septic tank absorption fields, and sewage lagoons. The shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling. The moderate permeability restricts the absorption of effluent in septic tank absorption fields. It can be overcome by enlarging the field. Seepage and slope are limitations on sites for sewage lagoons. Seepage can be controlled by sealing the lagoon. If the less sloping areas are selected as sites for the lagoons, less leveling and banking will be needed during construction.

The land capability classification is IIe, and the range site is Loamy Upland.

Gc—Geary silt loam, 3 to 7 percent slopes. This deep, moderately sloping, well drained soil is on side slopes and along drainageways in the uplands. Individual areas are irregular in shape and range from 50 to 800 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 6 inches thick. The subsurface layer also is dark grayish brown silt loam about 6 inches thick. The subsoil is firm silty clay loam about 35 inches thick. It is brown in the upper part and light brown in the lower part. The substratum to a depth of about 60 inches is light brown, calcareous clay loam. In places the surface layer is loam or fine sandy loam. In areas where the upper part of the subsoil has been mixed with the surface soil by tillage, the surface layer is silty clay loam.

Included with this soil in mapping are small areas of Armo, Harney, and Tobin soils. The calcareous Armo soils are on the lower side slopes. Harney soils have more clay in the subsoil than the Geary soil. They are on the upper side slopes. The occasionally flooded Tobin soils are on narrow flood plains. Included soils make up about 15 percent of the unit.

Permeability is moderate in the Geary soil, and surface runoff is medium. Available water capacity and natural fertility are high. The surface layer is medium acid and friable, and tilth is good. The shrink-swell potential is moderate in the subsoil.

Nearly all of the acreage is used for cultivated crops. This soil is moderately well suited to wheat, grain sorghum, and alfalfa. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the rate of water infiltration.

This soil is moderately well suited to dwellings, septic tank absorption fields, and sewage lagoons. The shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling. The moderate permeability restricts the absorption of effluent in septic tank absorption fields. It can be overcome by enlarging the field. Seepage and slope are limitations on sites for sewage lagoons. Seepage can be controlled by sealing the lagoon. If the less sloping areas are selected as sites for the lagoons, less leveling and banking will be needed during construction.

The land capability classification is IIIe, and the range site is Loamy Upland.

Hb—Harney silt loam, 1 to 3 percent slopes. This deep, gently sloping, well drained soil is on ridgetops and side slopes in the uplands. Individual areas are irregular in shape and range from 40 to 1,000 acres in size.

Typically, the surface soil is dark grayish brown silt loam about 14 inches thick (fig. 6). The subsoil is about 26 inches thick. The upper part is brown, very firm silty clay, and the lower part is pale brown, firm silty clay loam. The substratum to a depth of about 60 inches is pale brown silt loam. In areas where the subsoil has been mixed with the surface soil by tillage, the surface layer is pale brown.

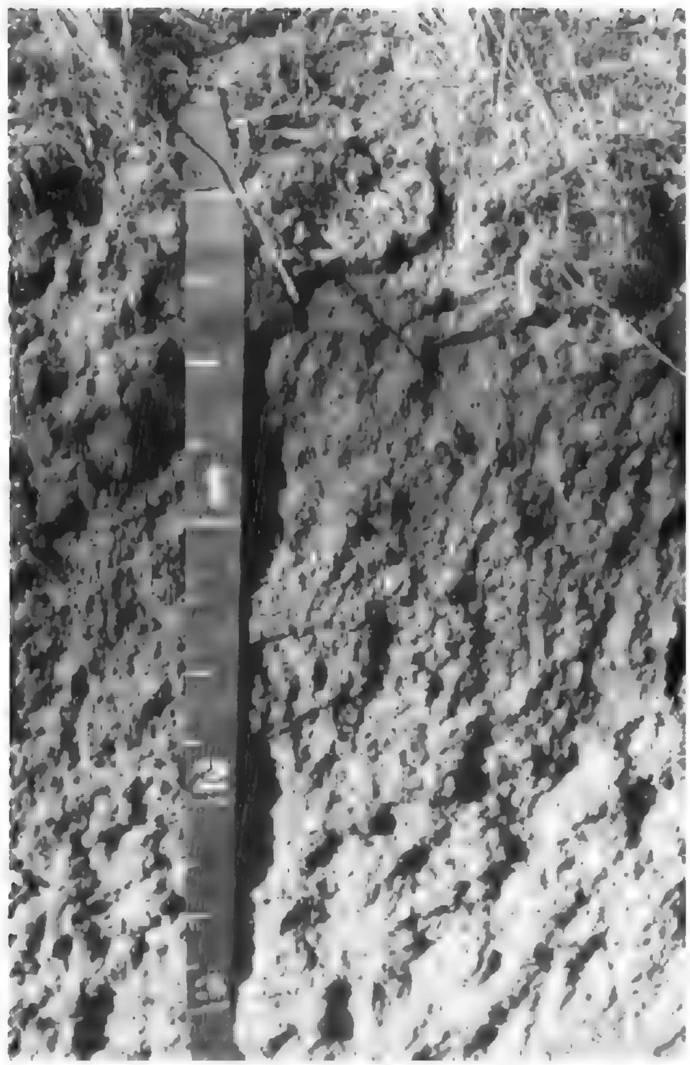

Figure 6.—Profile of Harney silt loam, 1 to 3 percent slopes. The dark surface soil is about 14 inches thick. Depth is marked in feet.

Included with this soil in mapping are small areas of Edalgo, Geary, Wakeen, and Wells soils. The moderately deep Edalgo and Wakeen soils are on the lower side slopes. Geary soils have less clay in the subsoil than the Harney soil. They are on the lower side slopes. The loamy Wells soils are on side slopes. Included soils make up about 10 percent of the unit.

Permeability is moderately slow in the Harney soil, and surface runoff is medium. Available water capacity and natural fertility are high. The surface layer is neutral and friable, and tilth is good. The shrink-swell potential is moderate in the subsoil.

Nearly all of the acreage is used for cultivated crops. This soil is well suited to wheat, grain sorghum, and alfalfa. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the rate of water infiltration.

The areas between cropland and range provide good habitat for upland wildlife, such as pheasants and quail. The habitat can be improved by planting trees or shrubs or by leaving crops unharvested in small areas between the cropland and the range.

This soil is well suited to dwellings with basements. It is moderately well suited to dwellings without basements and to septic tank absorption fields and sewage lagoons. The shrink-swell potential is a limitation on sites for dwellings without basements. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling. The moderately slow permeability restricts the absorption of effluent in septic tank absorption fields. It can be overcome by enlarging the field or by installing the lateral lines below the subsoil. Seepage and slope are limitations on sites for sewage lagoons. Seepage can be controlled by sealing the lagoon. If the less sloping areas are selected as sites for the lagoons, less leveling and banking will be needed during construction.

The land classification is IIe, and the range site is Loamy Upland.

He—Harney-Wakeen complex, 2 to 6 percent slopes. These moderately sloping, well drained soils are on ridgetops and side slopes in the uplands. Most areas are partly dissected by short drainageways. The deep Harney soil is on ridgetops and the upper side slopes. The moderately deep Wakeen soil is on the lower side slopes and on side slopes along drainageways. Individual areas are irregular in shape and range from 20 to 800 acres in size. They are about 60 percent Harney soil and 30 percent Wakeen soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is impractical.

Typically, the Harney soil has a surface layer of dark grayish brown silty clay loam about 6 inches thick. The subsoil is about 30 inches thick. The upper part is brown, very firm silty clay, and the lower part is pale brown, firm silty clay loam. The substratum to a depth of about 60 inches is pale brown, calcareous silt loam. In areas where the subsoil has been mixed with the surface soil by tillage, the surface layer is pale brown.

Typically, the Wakeen soil has a surface layer of dark grayish brown silt loam about 9 inches thick. The subsoil is friable silty clay loam about 21 inches thick. The upper part is pale brown, and the lower part is very pale brown. Soft, chalky limestone is at a depth of about 30 inches. In some places the depth to chalky limestone is more than 40 inches. In other places the surface layer is silty clay loam.

Included with these soils in mapping are small areas of the shallow Nibson soils on the lower side slopes. These included soils make up about 10 percent of the unit.

Permeability is moderately slow in the Harney soil and moderate in the Wakeen soil. Surface runoff is medium on both soils. Available water capacity is high in the Harney soil and moderate in the Wakeen soil. Natural fertility is high in the Harney soil and medium in the Wakeen soil. The surface layer of the Harney soil is neutral, and that of the Wakeen soil is moderately alkaline. The surface layer of both soils is friable and can be easily tilled. The shrink-swell potential is moderate in the subsoil of both soils. Root development is restricted by the bedrock at a depth of 20 to 40 inches in the Wakeen soil.

About half of the acreage is used for cultivated crops or is abandoned cropland. The rest is used as range. These soils are moderately well suited to wheat, grain sorghum, and alfalfa. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve fertility and tilth and increase the rate of water infiltration. Tilling the included areas of shallow Nibson soils is difficult and can damage the tillage implements.

These soils are suited to range. The native vegetation is dominantly big bluestem, little bluestem, indiangrass, and sideoats grama. In areas that are continually overgrazed, these grasses are replaced by less productive plants, such as tall dropseed, blue grama, buffalograss, and western ragweed. Water erosion is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a scheduled deferment of grazing during the growing

season, and a uniform distribution of grazing helps to keep the range in a productive condition.

The areas between cropland and range provide good habitat for upland wildlife, such as pheasants and quail. The habitat can be improved by planting trees or shrubs or by leaving crops unharvested in small areas between the cropland and the range.

The Wakeen soil is moderately well suited to dwellings. The Harney soil is well suited to dwellings with basements and moderately well suited to dwellings without basements. The shrink-swell potential of both soils and the depth to bedrock in the Wakeen soil are limitations. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling. Onsite inspection is needed to determine the depth to bedrock.

The Harney soil is moderately well suited to septic tank absorption fields and sewage lagoons. The moderately slow permeability restricts the absorption of effluent in septic tank absorption fields. It can be overcome by enlarging the field or by installing the lateral lines below the subsoil. Seepage and slope are limitations on sites for sewage lagoons. Seepage can be controlled by sealing the lagoon. If the less sloping areas are selected as sites for the lagoons, less leveling and banking will be needed during construction.

The Wakeen soil is poorly suited to septic tank absorption fields and sewage lagoons because of the depth to bedrock. The deeper adjacent soils are better sites.

The land capability classification is IVe. The Harney soil is in the Loamy Upland range site, and the Wakeen soil is in the Limy Upland range site.

Hm—Harney-Wells complex, 2 to 6 percent slopes. These deep, moderately sloping, well drained soils are on ridgetops and side slopes in the uplands. The silty Harney soil is on side slopes and narrow ridgetops. The loamy Wells soil is on the more sloping, lower side slopes. Individual areas are irregular in shape and range from 20 to a few hundred acres in size. They are about 60 percent Harney soil and 25 percent Wells soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is impractical.

Typically, the Harney soil has a surface layer of dark grayish brown silty clay loam about 5 inches thick. The subsoil is about 35 inches thick. The upper part is dark grayish brown, firm silty clay, and the lower part is pale brown, friable silty clay loam. The substratum to a depth of about 60 inches is very pale brown, calcareous silt loam.

Typically, the Wells soil has a surface layer of dark grayish brown loam about 6 inches thick. The subsoil is sandy clay loam about 26 inches thick. The upper part is brown, and the lower part is yellowish red. The substratum to a depth of about 60 inches is reddish yellow sandy loam.

Included with these soils in mapping are small areas of sandstone outcrops and small areas of Edalgo, Hedville, and Lancaster soils. The moderately deep Edalgo and Lancaster soils are on side slopes. The shallow Hedville soils and the rock outcrops are on narrow ridgetops. Included areas make up about 15 percent of the unit.

Permeability is moderately slow in the Harney soil and moderate in the Wells soil. Surface runoff is medium on both soils. Natural fertility and available water capacity are high. The surface layer of the Harney soil is neutral, and that of the Wells soil is slightly acid. The surface layer of both soils is friable and can be easily tilled. The shrink-swell potential is moderate in the subsoil of both soils.

About half of the acreage is used for cultivated crops, and the rest is used as range. These soils are moderately well suited to alfalfa, wheat, grain sorghum, and forage sorghum. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve fertility and tilth and increase the rate of water infiltration.

The native vegetation on these soils is dominantly little bluestem, big bluestem, indiangrass, and switchgrass. In areas that are continually overgrazed, these grasses are replaced by less productive plants, such as tall dropseed, Baldwin ironweed, and western ragweed. Water erosion is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a scheduled deferment of grazing during the growing season, and a uniform distribution of grazing helps to keep the range in a productive condition (fig. 7).

The areas between cropland and range provide good habitat for upland wildlife, such as pheasants and quail. The habitat can be improved by planting trees or shrubs or by leaving crops unharvested in small areas between the cropland and the range.

The Wells soil is moderately well suited to dwellings. The Harney soil is well suited to dwellings with basements and moderately well suited to dwellings without basements. The shrink-swell potential of both soils is a limitation. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling.

The Wells soil is well suited and the Harney soil moderately well suited to septic tank absorption fields. The moderately slow permeability in the Harney soil restricts the absorption of effluent. It can be overcome

Figure 7.—An area of the Harney-Wells complex, 2 to 6 percent slopes, where good grazing management has kept the range in a productive condition.

by enlarging the field or by installing the lateral lines below the subsoil.

These soils are moderately well suited to sewage lagoons. Slope and seepage are limitations. Sealing the lagoon helps to control seepage. If the less sloping areas are selected as sites for the lagoons, less leveling and banking will be needed during construction.

The land capability classification is IIIe. The range site is Loamy Upland.

Ho—Hord silt loam, nonflooded. This deep, nearly level, well drained soil is on high stream terraces. Individual areas are long and irregular in shape and range from 20 to 200 acres in size.

Typically, the surface layer is grayish brown silt loam about 5 inches thick (fig. 8). The subsurface layer is dark grayish brown silt loam about 8 inches thick. The subsoil is brown, friable silt loam about 28 inches thick. The substratum to a depth of about 60 inches is pale brown, calcareous silt loam.

Included with this soil in mapping are small areas of the moderately well drained Crete soils. These soils are in slight depressions. They make up about 10 percent of the unit.

Permeability is moderate in the Hord soil, and surface runoff is slow. Available water capacity and natural fertility are high. The surface layer is neutral and friable, and tilth is good.

Most of the acreage is used for cultivated crops. This soil is well suited to wheat, grain sorghum, forage sorghum, and alfalfa. Returning crop residue to the soil

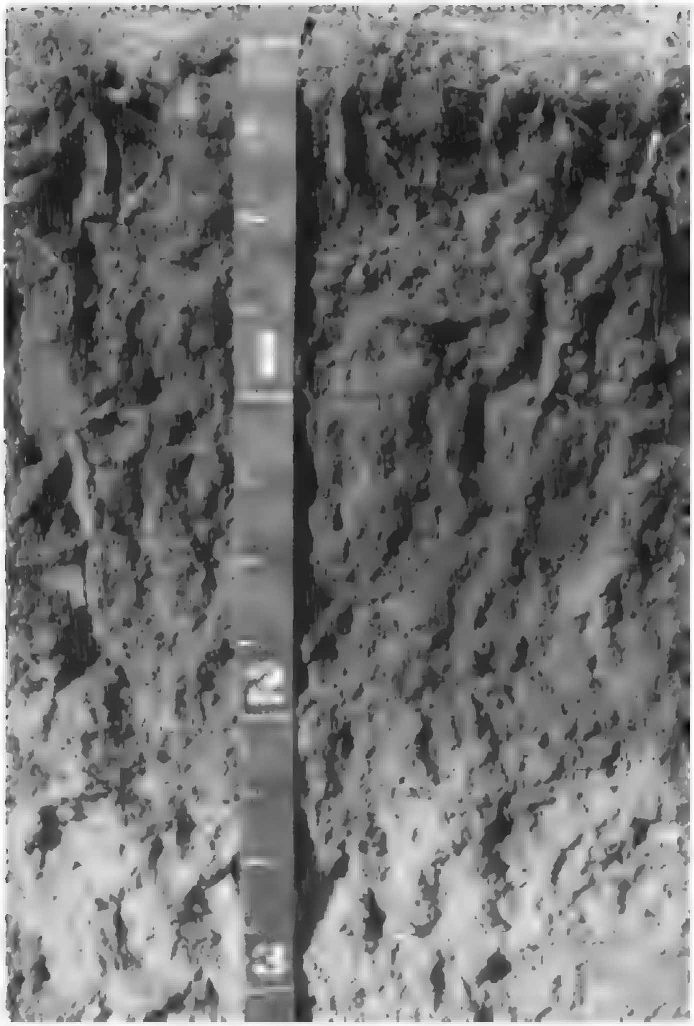

Figure 8.—Profile of Hord silt loam, nonflooded. Hord soils are dark to a depth of 20 to 40 inches. Depth is marked in feet.

and adding other organic material improve fertility and tilth and increase the rate of water infiltration.

This soil is well suited to dwellings and septic tank absorption fields and is moderately well suited to sewage lagoons. Seepage is a limitation on sites for sewage lagoons. It can be controlled by sealing the lagoon.

The land capability classification is I, and the range site is Loamy Terrace.

Hr—Hord silt loam, rarely flooded. This deep, nearly level, well drained soil is on stream terraces. Most areas have a long, shallow, dendritic drainage pattern. Individual areas are irregular in shape and range from 80 to 500 acres in size.

Typically, the surface layer is grayish brown silt loam about 5 inches thick. The subsurface layer is dark grayish brown silt loam about 8 inches thick. The subsoil is brown, friable silt loam about 28 inches thick. The substratum to a depth of about 60 inches is pale brown silt loam. In places the soil has lime within 15 inches of the surface and is dark to a depth of less than 20 inches. In small depressions the soil is more clayey.

Included with this soil in mapping are small areas of the well drained Roxbury and Tobin soils on narrow flood plains. These soils are occasionally flooded. Also included are frequently flooded areas in narrow stream channels. Included areas make up about 8 percent of the unit.

Permeability is moderate in the Hord soil, and surface runoff is slow. Available water capacity and natural fertility are high. The surface layer is neutral and friable, and tilth is good.

Most of the acreage is used for cultivated crops. This soil is well suited to wheat, grain sorghum, forage sorghum, and alfalfa. Returning crop residue to the soil and adding other organic material improve fertility and tilth and increase the rate of water infiltration.

Because of the flooding, this soil is poorly suited to dwellings and is only moderately well suited to septic tank absorption fields. Dikes, levees, and similar structures can lessen the hazard of flooding. Onsite inspection and knowledge of an area's flooding history are needed when building sites are selected.

This soil is moderately well suited to sewage lagoons. Seepage is a limitation. It can be controlled by sealing the lagoon.

The land capability classification is I, and the range site is Loamy Terrace.

Jc—Jansen sandy loam, 1 to 4 percent slopes. This deep, gently sloping, well drained soil is on ridgetops and side slopes in the uplands. Individual areas are irregular in shape and range from 20 to 200 acres in size.

Typically, the surface layer is dark grayish brown sandy loam about 5 inches thick. The subsurface layer also is dark grayish brown sandy loam. It is about 8 inches thick. The subsoil is yellowish brown, friable sandy clay loam about 15 inches thick. The upper part of the substratum is light yellowish brown loamy coarse sand. The lower part to a depth of about 60 inches is very pale brown coarse sand and gravel. In some places the surface layer is loamy sand. In other places the soil has a mildly alkaline or moderately alkaline solum and a calcareous substratum.

Included with this soil in mapping are small areas of Meadin and Wells soils. The excessively drained Meadin soils are on the upper side slopes. The moderately permeable Wells soils are on the lower side slopes. Included soils make up about 5 percent of the unit.

Permeability is moderate in the upper part of the Jansen soil and very rapid in the lower part. Surface runoff is slow. Available water capacity is moderate.

Natural fertility is medium. The surface layer is medium acid and very friable, and tilth is good.

About half of the acreage is used for cultivated crops. The rest is used mainly as range. This soil is moderately well suited to wheat, grain sorghum, and alfalfa. Water erosion and soil blowing are hazards if cultivated crops are grown. Terraces, grassed waterways, contour farming, cropping systems that include grasses or legumes, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve fertility and tilth and increase the rate of water infiltration.

The native vegetation on this soil is dominantly sand bluestem, little bluestem, indiangrass, and switchgrass. In areas that are continually overgrazed, these grasses are replaced by less productive plants, such as sand dropseed, tall dropseed, threeawn, and western ragweed. Water erosion and soil blowing are hazards if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a uniform distribution of grazing, and a scheduled deferment of grazing during the growing season helps to keep the range in a productive condition.

This soil is well suited to dwellings, but it is generally unsuited to septic tank absorption fields and is poorly suited to sewage lagoons. It readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity can result in pollution of the ground water. Seepage is a limitation on sites for sewage lagoons. It can be controlled by sealing the lagoon.

The land capability classification is IIIe, and the range site is Sandy.

Lh—Lancaster-Hedville loams, 3 to 20 percent slopes. These moderately sloping to moderately steep soils are on side slopes and narrow ridgetops in the uplands. Most areas are dissected by deeply entrenched drainageways. Some have sandstone rocks on the surface. The rocks are 0.5 foot to 4.0 feet in diameter and cover less than 1 percent of the surface. The moderately deep, well drained Lancaster soil is on side slopes above the Hedville soil. The shallow, somewhat excessively drained Hedville soil is on narrow ridgetops and sharp slope breaks. Individual areas are irregular in shape and range from 50 to 3,000 acres in size. They are about 45 percent Lancaster soil and 30 percent Hedville soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is impractical.

Typically, the Lancaster soil has a surface layer of dark grayish brown loam about 8 inches thick. The subsurface layer is brown loam about 8 inches thick. The subsoil is brown, firm sandy clay loam about 16 inches thick. Weathered, sandy shale is at a depth of about 32 inches. In places the depth to bedrock is more than 40 inches.

Typically, the Hedville soil has a surface layer of dark grayish brown loam about 7 inches thick. The subsoil is brown, very friable channery loam about 9 inches thick. Sandstone is at a depth of about 16 inches.

Included with these soils in mapping are small areas of Edalgo, Tobin, and Wells soils. Edalgo soils have more clay in the subsoil than the Lancaster and Hedville soils. They are on side slopes below the Hedville soil. The occasionally flooded Tobin soils are on narrow flood plains. The deep Wells soils are on side slopes below the Hedville soil. Also included, on the steeper side slopes, are small areas where sandstone and clayey shales crop out. Included areas make up about 25 percent of the unit.

Permeability is moderate in the Lancaster and Hedville soils. Surface runoff is medium on the Lancaster soil and rapid on the Hedville soil. Available water capacity is moderate in the Lancaster soil and very low in the Hedville soil. Natural fertility is medium in both soils. The surface layer of the Lancaster soil is medium acid, and that of the Hedville soil is slightly acid. Root development is restricted by the bedrock at a depth of 4 to 20 inches in the Hedville soil and 20 to 40 inches in the Lancaster soil. The shrink-swell potential is moderate in the subsoil of the Lancaster soil.

Nearly all areas are used as range. Because of a severe hazard of water erosion, the limited depth to bedrock, and the rocks on or near the surface, these soils are generally unsuited to cultivated crops. They are better suited to range. The native vegetation is dominantly big bluestem, little bluestem, and indiangrass. In areas that are continually overgrazed, these grasses are replaced by less productive plants, such as blue grama, buffalograss, and western ragweed. Water erosion is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a uniform distribution of grazing, and a scheduled deferment of grazing during the growing season helps to keep the range in a productive condition.

Sites that are suitable for stock water ponds are generally available in the larger areas of these soils. Many areas also are suitable for the development of springs.

Greater prairie chickens inhabit the areas of native grass. Properly managed range provides good habitat for this wildlife species.

The Lancaster soil is moderately well suited to dwellings. It is poorly suited to septic tank absorption fields and sewage lagoons. The shrink-swell potential, the depth to bedrock, and the slope are limitations on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the

foundations help to prevent the structural damage caused by shrinking and swelling. The buildings should be designed so that they conform to the natural slope of the land. The bedrock is soft and can easily be excavated. The moderate depth to bedrock is a limitation on sites for septic tank absorption fields and sewage lagoons. The deeper included soils on side slopes are better sites for these uses.

The Hedville soil is generally unsuited to building site development because of the shallow depth to bedrock and the slope.

The land capability classification is VIe. The Lancaster soil is in the Loamy Upland range site, and the Hedville soil is in the Shallow Sandstone range site.

Mb—McCook loam, occasionally flooded. This deep, nearly level, well drained soil is on flood plains. Individual areas are long and narrow and range from 10 to 50 acres in size.

Typically, the surface soil is grayish brown, calcareous loam about 15 inches thick. The next layer is light brownish gray, calcareous, very friable loam about 14 inches thick. The upper part of the substratum is light brownish gray, calcareous loam. The lower part to a depth of about 60 inches is light gray, calcareous very fine sandy loam. In places the surface soil is more than 20 inches thick.

Permeability is moderate, and surface runoff is slow. Available water capacity and natural fertility are high. The surface layer is mildly alkaline and friable, and tilth is good.

Nearly all of the acreage is used for cultivated crops. This soil is well suited to wheat, grain sorghum, forage sorghum, and alfalfa. If cultivated crops are grown, the flooding is a hazard. In years of above average rainfall, floodwater delays planting and harvesting and can damage crops. In other years, however, the extra moisture may increase crop yields. Returning crop residue to the soil and adding other organic material improve fertility and tilth and increase the rate of water infiltration.

This soil is unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is IIw, and the range site is Loamy Lowland.

Mc—McCook silt loam. This deep, nearly level, well drained soil is on stream terraces. It is subject to rare flooding. Individual areas are long and irregular in shape and range from 50 to 500 acres in size.

Typically, the surface soil is grayish brown, calcareous silt loam about 12 inches thick. The next layer is light brownish gray, calcareous, friable silt loam about 10 inches thick. The upper part of the substratum is light brownish gray, calcareous silt loam that has a few thin strata of more sandy material. The lower part to a depth of about 60 inches is light gray, calcareous silt loam. In places the surface soil is more than 20 inches thick. In some small areas it is less than 7 inches thick.

Permeability is moderate, and surface runoff is slow. Available water capacity and natural fertility are high. The surface layer is mildly alkaline and friable, and tilth is good.

Nearly all of the acreage is used for cultivated crops. This soil is well suited to wheat, grain sorghum, forage sorghum, and alfalfa. Returning crop residue to the soil and adding other organic material improve fertility and tilth and increase the rate of water infiltration.

The areas where cropland is adjacent to range or woodland provide habitat for many kinds of wildlife, including deer, quail, and numerous songbirds. The habitat can be improved by planting trees or shrubs or by leaving crops unharvested in small areas between the cropland and the range or woodland.

Because of the flooding, this soil is poorly suited to dwellings and is only moderately well suited to septic tank absorption fields. Dikes, levees, and similar structures can lessen the hazard of flooding. Onsite inspection and knowledge of an area's flooding history are needed when building sites are selected.

This soil is moderately well suited to sewage lagoons. Seepage is a limitation. It can be controlled by sealing the lagoon.

The land capability classification is I, and the range site is Loamy Terrace.

Mf—McCook silty clay loam, frequently flooded. This deep, nearly level, well drained soil is on flood plains near the upper end of the Kanopolis Reservoir. Individual areas are narrow and range from 10 to 100 acres in size.

Typically, the surface soil is dark gray, calcareous silty clay loam about 15 inches thick. The next layer is dark gray, calcareous, firm silty clay loam about 14 inches thick. The substratum to a depth of about 60 inches is light brownish gray, calcareous very fine sandy loam.

Permeability is moderate, and surface runoff is slow. Available water capacity and natural fertility are high. The surface layer is mildly alkaline.

Most areas are idle or are used as wildlife habitat. A few small areas on the higher parts of the landscape are cultivated in dry years. Because of a severe hazard of flooding, this soil is generally unsuited to cultivated crops. The native vegetation is commonly weeds, grasses, forbs, shrubs, and small trees. It provides food and cover for many kinds of wildlife, including quail, deer, rabbits, and songbirds. The wildlife population can be increased by planting trees and shrubs in the areas bordering cropland.

This soil is unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is Vw. No range site is assigned.

Mn—Meadin sandy loam, 3 to 15 percent slopes. This deep, moderately sloping and strongly sloping, excessively drained soil is on ridgetops and side slopes in the uplands. Individual areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the surface layer is dark grayish brown sandy loam about 7 inches thick. The next layer is dark grayish brown, very friable gravelly sandy loam about 7 inches thick. The substratum to a depth of about 60 inches is very pale brown gravelly coarse sand. In places the depth to gravelly coarse sand is more than 20 inches.

Permeability is moderate in the upper part of the profile and very rapid in the substratum. Surface runoff is slow. Available water capacity and natural fertility are low. The surface layer is slightly acid.

Most areas are used as range. Because of the low available water capacity, this soil is generally unsuited to cultivated crops. It is better suited to range. The native vegetation is dominantly sand bluestem, little bluestem, indiangrass, and switchgrass. In areas that are continually overgrazed, these grasses are replaced by less productive plants, such as sand dropseed, tall dropseed, threeawn, and western ragweed. Measures that maintain an adequate cover of plants and surface litter increase the moisture supply. Grazing management that includes a proper stocking rate, a uniform distribution of grazing, and a scheduled deferment of grazing during the growing season helps to keep the range in a productive condition.

This soil is moderately well suited to dwellings, but it is generally unsuited to septic tank absorption fields and is poorly suited to sewage lagoons. The slope is a limitation on sites for dwellings. The buildings should be designed so that they conform to the natural slope of the land. The soil readily absorbs but does not adequately filter the effluent from septic tanks. The poor filtering capacity can result in pollution of the ground water. Seepage is a limitation on sites for sewage lagoons. It can be controlled by sealing the lagoon.

The land capability classification is VIs, and the range site is Sandy.

Nw—Nibson-Wakeen silt loams, 5 to 25 percent slopes. These moderately sloping to moderately steep soils are on ridgetops and side slopes in the uplands. Most areas are dissected by shallow drainageways. The shallow, somewhat excessively drained Nibson soil is on sharp slope breaks and on side slopes. The moderately deep, well drained Wakeen soil is on the less sloping ridgetops and side slopes above the Nibson soil. Individual areas generally are narrow and irregular in shape and range from 10 to several hundred acres in size. They are about 60 percent Nibson soil and 30 percent Wakeen soil. The two soils occur as areas so intricately mixed or so small that mapping them separately is impractical.

Typically, the Nibson soil has a surface layer of dark grayish brown, calcareous silt loam about 8 inches thick. The subsoil is pale brown, calcareous, friable silt loam about 6 inches thick. The substratum is very pale brown, calcareous silt loam about 5 inches thick. Shale and chalky limestone are at a depth of about 19 inches. In places the surface layer is silty clay loam.

Typically, the Wakeen soil has a surface layer of dark gray, calcareous silt loam about 9 inches thick. The subsoil is calcareous, friable silt loam about 21 inches thick. The upper part is grayish brown, and the lower part is pale brown. Soft, chalky limestone is at a depth of about 30 inches. In places the soil is more than 40 inches deep over chalky shale.

Included with these soils in mapping are small areas of Armo and Harney soils and limestone outcrops. The deep Armo soils are on the lower side slopes. The deep Harney soils have more clay in the subsoil than the Nibson and Wakeen soils. They are on ridgetops. The limestone outcrops are on the steeper short side slopes. Included areas make up about 10 percent of the unit.

Permeability is moderate in the Nibson and Wakeen soils. Available water capacity is low in the Nibson soil and moderate in the Wakeen soil. Surface runoff is medium on the Wakeen soil and rapid on the Nibson soil. Natural fertility is medium in the Wakeen soil and low in the Nibson soil. Root penetration is restricted by the bedrock at a depth of 10 to 20 inches in the Nibson soil and 20 to 40 inches in the Wakeen soil. The surface layer of both soils is moderately alkaline. The shrink-swell potential is moderate in the subsoil.

Most areas are used as range. Because of a severe hazard of water erosion, the limited depth to bedrock, and rocks on or near the surface, these soils are generally unsuited to cultivated crops. They are better suited to range. The native vegetation is dominantly big bluestem, little bluestem, and sideoats grama. In areas that are continually overgrazed, these grasses are replaced by less productive plants, such as blue grama, buffalograss, and western ragweed. Water erosion is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a uniform distribution of grazing, and a scheduled deferment of grazing during the growing season helps to keep the range in a productive condition. Suitable sites for stock water ponds are generally available in the larger areas of these soils.

The Wakeen soil is moderately well suited to dwellings and poorly suited to septic tank absorption fields and sewage lagoons. The shrink-swell potential, the depth to bedrock, and the slope are limitations on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling

with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling. The bedrock is soft and can be easily excavated. The buildings should be designed so that they conform to the natural slope of the land. The depth to bedrock and the slope are limitations on sites for septic tank absorption fields and sewage lagoons. The deeper included soils are better sites for these uses.

The Nibson soil is generally unsuited to building site development because of the depth to bedrock and the slope.

The land capability classification is VIe, and the range site is Limy Upland.

Rb—Roxbury silt loam. This deep, nearly level, well drained soil is on terraces along the larger streams in the county. It is subject to rare flooding. Individual areas are irregular in shape and range from 20 to several hundred acres in size.

Typically, the surface layer is dark grayish brown, calcareous silt loam about 20 inches thick. The subsurface layer also is dark grayish brown, calcareous silt loam. It is about 12 inches thick. The substratum to a depth of about 60 inches is calcareous silt loam. The upper part is grayish brown, and the lower part is light brownish gray. In some places the soil has a subsoil of very fine sandy loam. In other places free lime is below a depth of 15 inches.

Permeability is moderate, and surface runoff is slow. Available water capacity and natural fertility are high. The surface layer is mildly alkaline and friable, and tilth is good. The shrink-swell potential is moderate below the surface layer.

Most areas are used for cultivated crops. This soil is well suited to grain sorghum, forage sorghum, wheat, and alfalfa. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the rate of water infiltration.

Because of the flooding, this soil is poorly suited to dwellings and is only moderately well suited to septic tank absorption fields. Dikes, levees, and similar structures can lessen the hazard of flooding. Onsite inspection and knowledge of an area's flooding history are needed when building sites are selected.

This soil is moderately well suited to sewage lagoons. Seepage is a limitation. It can be controlled by sealing the lagoon.

The land capability classification is I, and the range site is Loamy Terrace.

Rf—Roxbury silt loam, occasionally flooded. This deep, nearly level, well drained soil is on flood plains along rivers, creeks, and intermittent drainageways. Individual areas are 200 to 1,000 feet wide, 0.25 mile to more than 2 miles long, and 10 to 300 acres in size.

Typically, the surface layer is dark grayish brown, calcareous silt loam about 20 inches thick. The subsurface layer also is dark grayish brown, calcareous silt loam. It is about 12 inches thick. The substratum to a depth of about 60 inches is calcareous silt loam. The upper part is grayish brown, and the lower part is light brownish gray. In some places the soil has a subsoil of loam or clay loam. In other places free lime is below a depth of 15 inches.

Permeability is moderate, and surface runoff is slow. Available water capacity and natural fertility are high. The surface layer is mildly alkaline and friable, and tilth is good. The shrink-swell potential is moderate below the surface layer.

About two-thirds of the acreage is cultivated, and the rest is used as range. This soil is well suited to wheat, grain sorghum, forage sorghum, and alfalfa. The flooding delays harvesting and planting and damages crops in some years, but in other years the extra moisture may increase crop yields. Overcoming the flooding hazard is difficult without major flood-control measures. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the rate of water infiltration.

The native vegetation on the soil is dominantly big bluestem, indiangrass, and switchgrass. In areas that are continually overgrazed, these grasses are replaced by less productive plants, such as western wheatgrass, tall dropseed, Baldwin ironweed, and western ragweed. Grazing management that includes a proper stocking rate, a scheduled deferment of grazing during the growing season, and a uniform distribution of grazing helps to keep the range in a productive condition. Placing salt blocks on the adjacent upland soils helps to distribute grazing more evenly.

This soil is unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is IIw, and the range site is Loamy Lowland.

To—Tobin silt loam, occasionally flooded. This deep, nearly level, well drained soil is on flood plains along small creeks and drainageways. Individual areas are 200 to 800 feet wide, 0.25 mile to several miles long, and 20 to several hundred acres in size.

Typically, the surface layer is dark grayish brown silt loam about 20 inches thick. The next layer is dark grayish brown, friable silt loam about 12 inches thick. The substratum to a depth of about 60 inches is grayish brown, calcareous silt loam. In places the soil is browner below a depth of 20 inches. In a few areas the surface layer is calcareous. In some areas it is loam.

Permeability is moderate, and surface runoff is slow. Available water capacity and natural fertility are high. The surface layer is slightly acid and friable, and tilth is good. The shrink-swell potential is moderate.

About half of the acreage is used for cultivated crops, and the rest is used mainly as range. This soil is well suited to wheat, grain sorghum, forage sorghum, and alfalfa. Flooding is a hazard if cultivated crops are grown. Floodwater delays planting and harvesting and damages crops in some years, but in other years the extra moisture may increase crop yields. Overcoming the flooding hazard is difficult without major flood-control measures. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the rate of water infiltration.

The native vegetation on this soil is dominantly big bluestem, indiangrass, and switchgrass. In areas that are continually overgrazed, these grasses are replaced by less productive plants, such as western wheatgrass, tall dropseed, Baldwin ironweed, and western ragweed. Grazing management that includes a proper stocking rate, a uniform distribution of grazing, and a scheduled deferment of grazing during the growing season helps to keep the range in a productive condition. In areas used for hay, early mowing allows the grasses to recover before they are affected by frost.

The areas where cropland is adjacent to range or woodland provide habitat for many kinds of wildlife, including deer, quail, and numerous songbirds. The habitat can be improved by planting trees or shrubs or by leaving crops unharvested in small areas between the cropland and the range or woodland.

This soil is unsuited to building site development because of the flooding. Overcoming the hazard is difficult without major flood-control measures.

The land capability classification is IIw, and the range site is Loamy Lowland.

Wr—Wells loam, 1 to 3 percent slopes. This deep, gently sloping, well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 20 to 250 acres in size.

Typically, the surface layer is dark grayish brown loam about 9 inches thick. The subsoil is about 33 inches thick. The upper part is brown, friable clay loam, and the lower part is light brown, firm sandy clay loam. The substratum to a depth of about 60 inches is light brown sandy clay loam. In places the soil is more silty.

Included with this soil in mapping are small areas of Harney soils. These soils have more clay in the subsoil than the Wells soil. They are on the upper side slopes. They make up about 5 percent of the unit.

Permeability is moderate in the Wells soil, and surface runoff is medium. Available water capacity is high. Natural fertility is medium. The surface layer is slightly acid and very friable, and tilth is good. The shrink-swell potential is moderate in the subsoil.

Nearly all of the acreage is used for cultivated crops. This soil is well suited to wheat, grain sorghum, and alfalfa. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the rate of water infiltration.

This soil is well suited to septic tank absorption fields. It is moderately well suited to dwellings and sewage lagoons. The shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the structural damage caused by shrinking and swelling. Seepage and slope are limitations on sites for sewage lagoons. Seepage can be controlled by sealing the lagoon. If the less sloping areas are selected as sites for the lagoons, less leveling and banking will be needed during construction.

The land capability classification is IIe, and the range site is Loamy Upland.

Ws—Wells loam, 3 to 7 percent slopes. This deep, moderately sloping, well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 20 to several hundred acres in size.

Typically, the surface layer is dark grayish brown loam about 11 inches thick. The subsoil is firm sandy clay loam about 33 inches thick. The upper part is brown, and the lower part is yellowish red. The substratum to a depth of about 60 inches is reddish yellow sandy loam. In places the soil is more silty. The surface layer is light brown sandy clay loam in areas where it has been mixed with the subsoil by tillage.

Included with this soil in mapping are small areas of Edalgo, Jansen, and Lancaster soils on the lower side slopes. Edalgo and Lancaster soils are moderately deep. Jansen soils have sand and gravel at a depth of 20 to 36 inches. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Wells soil, and surface runoff is medium. Available water capacity is high. Natural fertility is medium. The surface layer is slightly acid and very friable, and tilth is good. The shrink-swell potential is moderate in the subsoil.

About half of the acreage is used for cultivated crops or is abandoned cropland. The rest is used as range. This soil is moderately well suited to wheat, grain sorghum, and forage sorghum. Water erosion is a hazard if cultivated crops are grown. Terraces, grassed waterways, contour farming, and a system of conservation tillage that leaves all or part of the crop residue on the surface help to prevent excessive soil loss. Returning crop residue to the soil and adding other organic material improve tilth and fertility and increase the rate of water infiltration.

The native vegetation on this soil is dominantly big bluestem, little bluestem, indiangrass, and switchgrass. In areas that are continually overgrazed, these grasses

are replaced by less productive plants, such as blue grama, buffalograss, and western ragweed. Water erosion is a hazard if the range is overgrazed. An adequate plant cover helps to prevent excessive soil loss. Grazing management that includes a proper stocking rate, a uniform distribution of grazing, and a scheduled deferment of grazing during the growing season helps to keep the range in a productive condition. Seeding native grasses helps to restore the productivity of abandoned cropland. In areas used for hay, early mowing allows the grasses to recover before they are affected by frost.

The areas where cropland is adjacent to range provide good habitat for upland wildlife, such as pheasants. The habitat can be improved by planting trees or shrubs or by leaving crops unharvested in small areas between the cropland and the range.

This soil is well suited to septic tank absorption fields. It is moderately well suited to dwellings and sewage lagoons. The shrink-swell potential is a limitation on sites for dwellings. Properly designing and reinforcing foundations, installing foundation drains, and backfilling with suitable coarse textured material around the foundations help to prevent the damage caused by shrinking and swelling. Seepage and slope are limitations on sites for sewage lagoons. Seepage can be controlled by sealing the lagoon. If the less sloping areas are selected as sites for the lagoons, less leveling and banking will be needed during construction.

The land capability classification is IIIe, and the range site is Loamy Upland.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 297,000 acres in the survey area, or more than 64 percent of the total acreage, meets the soil requirements for prime farmland. Scattered areas of this land are throughout the county, but most are in the Crete-Harney, Wells-Meadin, and the McCook-Roxbury associations, which are described under the heading "General Soil Map Units." About 208,000 acres of this prime farmland is used for crops. The crops grown on this land, mainly wheat and grain sorghum, account for an estimated two-thirds of the county's total agricultural income each year.

The map units in the survey area that are considered prime farmland are listed in this section. The Jansen soil on this list is considered prime farmland only in areas where it is irrigated. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

The map units that meet the soil requirements for prime farmland are:

Ar	Armo loam, 3 to 7 percent slopes
Cb	Cass fine sandy loam
Cd	Crete silt loam, 0 to 2 percent slopes
Gb	Geary silt loam, 1 to 3 percent slopes
Gc	Geary silt loam, 3 to 7 percent slopes
Hb	Harney silt loam, 1 to 3 percent slopes
He	Harney-Wakeen complex, 2 to 6 percent slopes
Hm	Harney-Wells complex, 2 to 6 percent slopes
Ho	Hord silt loam, nonflooded
Hr	Hord silt loam, rarely flooded
Jc	Jansen sandy loam, 1 to 4 percent slopes (where irrigated)
Mb	McCook loam, occasionally flooded
Mc	McCook silt loam
Rb	Roxbury silt loam
Rf	Roxbury silt loam, occasionally flooded
To	Tobin silt loam, occasionally flooded
Wr	Wells loam, 1 to 3 percent slopes
Ws	Wells loam, 3 to 7 percent slopes

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

The soils in the survey area are assigned to a land capability classification and a range site at the end of each map unit description and in tables 5 and 6. The capability classification and range site for each map unit also are shown in the section "Interpretive Groups," which follows the tables at the back of this survey.

Crops

Jerry B. Lee, conservation agronomist, Soil Conservation Service, helped prepare this section.

General management needed for crops is suggested in this section. The crops best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 199,000 acres in Ellsworth County, or 43 percent of the total acreage, is used for cultivated crops. During the period 1971 to 1981, wheat was grown on about 50 percent of the cropland, sorghum on 11 percent, and alfalfa, tame hay, oats, barley, rye, and other miscellaneous crops on 20 percent (*3*). About 19 percent of the cropland was summer fallowed. The acreage used for wheat increased during this period compared to that of the previous 10-year period. The acreage of all other crops remained the same.

Crop production can be increased on most farms by applying the latest technology. This soil survey can facilitate the application of such technology. The main concerns in managing the soils in Ellsworth County for cultivated crops are controlling erosion, conserving or increasing the moisture supply in the soils, and maintaining fertility and tilth.

Water erosion is the major hazard on about 35 percent of the cropland. It occurs mainly on soils that have a slope of 2 percent or more. Examples are Armo, Edalgo, Geary, Harney, Jansen, Wakeen, and Wells soils.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as Crete, Edalgo, and Harney soils. Secondly, erosion pollutes streams with sediments, nutrients, and pesticides. Control of erosion minimizes

the pollution of streams and improves the quality of water.

Erosion-control practices provide a protective cover, reduce the runoff rate, and increase the rate of water infiltration. A cropping system that keeps a plant cover on the surface for extended periods helps to control erosion and preserves the productive capacity of the soils.

Conservation tillage and conservation cropping systems help to control water erosion. A system of conservation tillage leaves all or part of the crop residue on the surface. Examples are stubble mulching and chemical fallow. When these systems are applied, the stubble of crops or crop residue is left essentially in place to provide a protective cover before and during the preparation of a seedbed and at least a partial cover for the succeeding crop. Drilled crops, such as small grain, are alternated with row crops in a conservation cropping system.

Terraces, diversions, grassed waterways, and contour farming are needed in combination with conservation tillage on soils that have a slope of more than 2 percent. If a system of conservation tillage is not applied, they also are needed on soils that have a slope of more than 1 percent. Terraces and diversions help to control erosion by shortening the length of slopes and reducing the runoff rate. They are most practical on deep, well drained soils that have uniform slopes. Contour farming should generally be used in combination with terraces (fig. 9). It is best suited to soils that have smooth, uniform slopes and are suitable for terracing.

Inadequate rainfall in some years is a problem on all of the cropland in the county. As a result, the supply of water stored in the soils should be conserved or increased by summer fallowing and terracing. Summer

Figure 9.—A combination of terraces and contour farming.

fallowing allows the soil to store moisture during the summer. It is most effective when the crop residue is managed by stubble mulching or by chemical fallow. Stubble mulch is effective in trapping winter snow. Both stubble mulching and terracing reduce the runoff rate.

Organic matter is a storehouse of available plant nutrients. It increases the rate of water intake, helps to prevent surface crusting, helps to control erosion, and promotes good tilth. About half of the cropland in the county occurs as soils that have a silt loam surface layer. During periods of intensive rainfall, a crust forms at the surface. When dry, the crusted surface becomes nearly impervious to water. As a result, the runoff rate is increased. Regularly adding organic material and leaving crop residue on the surface help to prevent excessive crusting, increase the rate of water infiltration, and reduce the runoff rate and the hazard of erosion.

Plants on most of the arable soils in the county respond well to applications of nitrate and phosphate fertilizer. On all soils the amount of fertilizer to be applied should be based on the results of soil tests, on the needs of the crop, on the expected level of yields, and on the experience of farmers. The Cooperative Extension Service can help to determine the kind and amount of fertilizer needed.

Information about the design of erosion-control practices is available in the local office of the Soil Conservation Service. The latest information about growing crops can be obtained from the Cooperative Extension Service or the Soil Conservation Service.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e*

shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

The capability classification of each map unit is given in the section "Detailed Soil Map Units," in the yields table, and in the section "Interpretive Groups."

Rangeland

Mike Meurisse, range conservationist, Soil Conservation Service, helped prepare this section.

About 200,000 acres in Ellsworth County, or more than 43 percent of the total acreage, is range. About 37 percent of the farm income in the county is derived from the sale of livestock, principally cattle.

Cow-calf enterprises are dominant. In the western half of the county, most of the range occurs as tracts that are 40 to 320 acres in size. These tracts are intermingled with larger acreages of cropland. The larger ranches are more prevalent in the eastern part of the county. These range from 1,000 to 6,000 acres in size. Some include small areas of cropland.

Some farmers and ranchers extend the grazing season with cool-season tame pasture grasses, principally bromegrass. Many also supplement the range forage with crop residue. During winter, protein concentrates are used to supplement low-quality, dormant forage. During most winters hay is fed to livestock for short periods when pastures of native grass are covered with snow (fig. 10).

Because of soil characteristics and the amount of annual precipitation, the county is in a transition zone between the mixed grass prairie to the west and the tall grass prairie to the east. In the western part of the county, the plant communities are dominated by big bluestem, little bluestem, and grama. In the eastern part, they are dominated by bluestems, switchgrass, and indiangrass.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Table 6 shows, for nearly every soil, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as rangeland or are suited to use as rangeland are listed. An explanation of the column headings in table 6 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre of air-dry vegetation. Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as exposure, amount of shade, recent rains, and unseasonable dry periods.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition*, the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about

Figure 10.—Native hay on Harney and Wells soils in the foreground. The hay is fed to livestock in winter.

the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Overgrazing has reduced forage production in some areas of the county. Proper stocking rates, a uniform distribution of grazing, and a scheduled deferment of grazing during the growing season help to keep the range in a productive condition. Measures that control brush and reseeding of marginal cropland and of overgrazed range can increase forage production in some areas.

Native Woodland, Windbreaks, and Environmental Plantings

Keith A. Ticknor, forester, Soil Conservation Service, helped prepare this section.

About 6,000 acres in Ellsworth County, or 1.3 percent of the total acreage, is native woodland. Only about half of this land is suitable for commercial timber production. The woodland is in scattered areas throughout the county. It occurs as irregular tracts and narrow bands along the numerous streams and along the Smoky Hill River. Upland drainageways support only a few scattered trees in the wet areas, generally at the lower end of the drainageway. The major wooded area is in the McCook-Roxbury association, along the Smoky Hill River, but wooded areas along streams are in all of the associations described under the heading "General Soil Map Units."

The woodland occurs as three main forest cover types—hackberry-American elm-green ash, bur oak, and cottonwood. The species composition varies from one stream to another. Bur oak, green ash, hackberry, and eastern cottonwood are the dominant species along many of the streams. Other species are American elm, boxelder, black walnut, common chokecherry, American plum, Kentucky coffeetree, red mulberry, black willow, gooseberry, smooth sumac, elderberry, and sandbar willow.

The dominant species in the wooded areas along the Smoky Hill River are bur oak, eastern cottonwood, green ash, and hackberry. In the eastern part of the county, bur oak is a major species along this river. In the western part, however, this species is rare.

Many of the trees, especially the bottom-land species, have commercial value for wood products. Many of the soils have good potential for Christmas trees and for the trees used in the production of veneer, sawtimber, and other wood products. Only a small part of the woodland, however, is managed for commercial wood production. Most of the wooded areas are privately owned tracts making up only a small acreage of the farms. Most of the acreage is cropland that is unlikely to be converted to land used for commercial wood production. The soils on bottomland produce high-value hardwoods within a short period. In contrast, upland soils produce low-value trees over a long period.

Trees grow on most of the farmsteads in Ellsworth County. They were planted at various times by the landowners. Some are windbreaks, but most are environmental or ornamental plantings. Siberian elm, eastern redcedar, and lilac are the most common species (fig. 11). Other commonly planted species are honeylocust, Russian-olive, oriental arborvitae, Kentucky coffeetree, Austrian pine, and tamarisk.

Tree planting is a continual need because old trees pass maturity and deteriorate, because some trees are destroyed by insects, disease, or storms, and because new plantings are needed on expanding farmsteads. Renovation measures, such as removal and replacement or supplemental planting, help to maintain the effectiveness of the windbreaks.

The county has only a few field windbreaks, mainly in the southern part. These windbreaks are generally hedgerows of osageorange. Common chokecherry and golden currant are volunteer species in the understory. The hedgerows were planted as property lines and field boundaries, as living fences, and as a source of wood for posts. Many are being removed because fields are being enlarged.

Shelterbelts were planted during the Prairie States Forestry Project between 1935 and 1942. They consisted of 10 rows of trees and shrubs. Commonly, the trees and shrubs in one or more of the rows are now dead or have been removed and an understory of volunteer eastern redcedar, Siberian elm, hackberry, green ash, common chokecherry, and golden currant has invaded. Some of the planted species in the shelterbelts are eastern redcedar, ponderosa pine, Russian mulberry, green ash, hackberry, honeylocust, Siberian elm, osageorange, Russian-olive, and eastern cottonwood.

In order for windbreaks and environmental plantings to fulfill their intended purpose, the soils on the site should be suited to the trees or shrubs selected for planting. Permeability, available water capacity, fertility, soil depth, and texture greatly affect the growth rate.

Establishing trees and shrubs is somewhat difficult in Ellsworth County. The moisture supply is normally short during the growing season, and hot, drying winds are common. Unsuccessful windbreaks and environmental plantings result mainly from dry conditions and competition from weeds and grasses. Proper site preparation before planting and control of competing vegetation after planting are important concerns in establishing and maintaining a windbreak. Supplemental watering is needed during dry periods, and cover crops are needed to protect the surface from hot winds.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Figure 11.—A windbreak of eastern redcedar on an Armo soil.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

Ellsworth County has several areas of scenic, geologic, and historical interest. Kanopolis Lake and its four associated recreation areas provide facilities for boating, fishing, picnicking, camping, and swimming. About 14,000 acres around the lake is open to the public for hunting during the fall season. Numerous farm ponds and the Smoky Hill River and its tributaries provide opportunities for recreation on privately owned land. The Dakota Sandstone hills add to the natural beauty of the county. These hills are covered with native grass and wild flowers, which bloom periodically throughout the summer. Mushroom Rock State Park and Old Fort Harker are of special interest.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation, such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Wildlife Habitat

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

The primary game species in Ellsworth County are ringneck pheasant, bobwhite quail, mourning dove, fox squirrel, cottontail rabbit, white-tailed deer, and several species of waterfowl. Upland game birds are hunted mainly on privately owned land. Duck and goose hunting is usually good at Kanopolis Lake and on farm ponds during the open season. Birdwatchers and wildlife photographers frequently use the lake area.

Nongame species are numerous because of the diversity of habitat types in the county. Cropland, woodland, and grassland are intermixed throughout the county. This intermixture creates the desirable edge effect conducive to a variety of wildlife species. Establishing additional fringe areas can increase the wildlife population.

Furbearers are common along many of the streams and around Kanopolis Lake. Coyote, raccoon, muskrat, and beaver are trapped on a limited basis.

Stock water ponds, streams, and Kanopolis Lake provide good to excellent fishing throughout most of the year. The species commonly caught are largemouth bass, bluegill, channel cat, bullhead, and flathead catfish. Also, crappie, walleye, white bass, and striped bass are caught at the lake.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair*

indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, grain sorghum, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, switchgrass, indiangrass, ragweed, sunflowers, native legumes, goldenrod, beggarweed, wheatgrass, and grama.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, cottonwood, sycamore, hackberry, black walnut, willow, ash, and mulberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, plum, fragrant sumac, and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are eastern redcedar, pine, spruce, and juniper.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are gooseberry, dogwood, blackberry, buckbrush, prairie rose, and sumac.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, prairie cordgrass, buttonbush, indigobush, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, ponds, and lakes.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, mourning dove, meadowlark, field sparrow, and cottontail rabbit.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include owls, hawks, wild turkey, thrushes, woodpeckers, squirrels, opossum, raccoon, and white-tailed deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, red-winged blackbirds, muskrat, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include antelope, deer, coyotes, badgers, jackrabbits, hawks, sage grouse, meadowlarks, and killdeer.

Technical assistance in planning wildlife developments and in determining the vegetation suitable for planting can be obtained from the local office of the Soil Conservation Service. Additional information and assistance can be obtained from the Kansas Fish and Game Commission and from the Cooperative Extension Service.

Engineering

Glen Creager, Jr., civil engineer, Soil Conservation Service, helped prepare this section.

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building Site Development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They

have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Sanitary Facilities

Table 11 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary

landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 17.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter (fig. 12). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

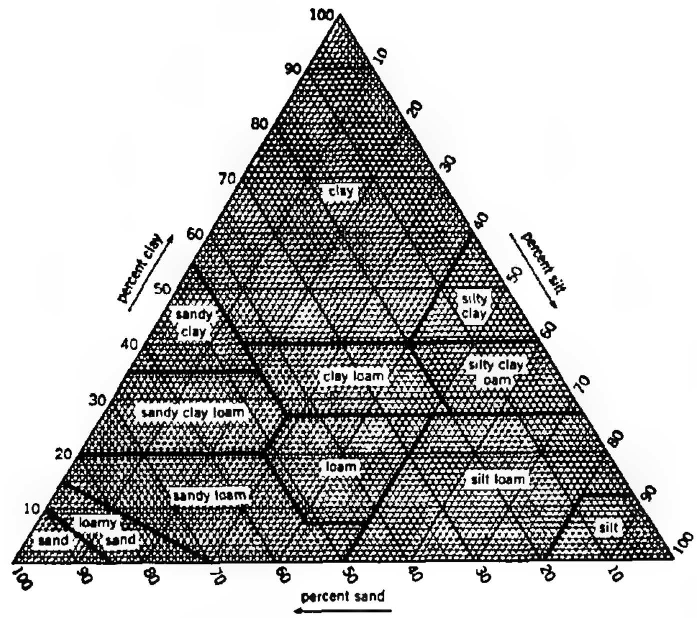

Figure 12.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in

group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type

of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 15, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or

soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs, on the average, once or less in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering Index Test Data

Table 17 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the Kansas Department of Transportation.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*5*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Ustoll (*Ust*, meaning intermittent dryness, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiustolls (*Argi*, meaning argillic horizon, plus *ustoll*, the suborder of the Mollisols that has an ustic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Argiustolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine, montmorillonitic, mesic Typic Arguistolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*4*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*5*). Unless otherwise stated, matrix colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Armo Series

The Armo series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in loamy colluvium weathered from chalky limestone. Slope ranges from 3 to 15 percent.

Armo soils are commonly adjacent to Harney, Nibson, Roxbury, and Wakeen soils. The silty Harney soils have a noncalcareous surface layer and have more clay in the subsoil than the Armo soils. They are on ridgetops and the upper side slopes. The shallow Nibson soils and the moderately deep Wakeen soils are on side slopes. The silty Roxbury soils have a mollic epipedon that is more

than 20 inches thick. They are on stream terraces and flood plains.

Typical pedon of Armo loam, 7 to 15 percent slopes, 115 feet north and 85 feet west of the southeast corner of sec. 2, T. 14 S., R. 8 W.

A1—0 to 9 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; many fine roots; less than 10 percent irregular fragments of limestone 2 to 5 millimeters in diameter; strong effervescence; moderately alkaline; clear smooth boundary.

A2—9 to 15 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak coarse granular structure; slightly hard, friable; many fine roots; about 10 percent irregular fragments of limestone 2 millimeters to 2 centimeters in diameter; strong effervescence; moderately alkaline; clear smooth boundary.

Bw—15 to 30 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; weak fine subangular blocky structure; slightly hard, friable; few fine roots; less than 10 percent irregular fragments of limestone 2 millimeters to 1 centimeter in diameter; strong effervescence; moderately alkaline; gradual wavy boundary.

C—30 to 60 inches; very pale brown (10YR 7/3) gravelly clay loam, pale brown (10YR 6/3) moist; massive; slightly hard, friable; few fine roots; about 30 percent irregular fragments of limestone and medium and coarse pebbles; violent effervescence; moderately alkaline.

The mollic epipedon is 7 to 20 inches thick. The depth to free carbonates is 0 to 6 inches. Reaction is neutral to moderately alkaline throughout the profile.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. It is typically loam, but in some pedons it is silt loam. The Bw horizon has hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is clay loam, loam, or silty clay loam. The C horizon has the same color range as the Bw horizon. It is clay loam or gravelly clay loam. The gravel is mostly lime fragments, which make up 10 to 40 percent of this horizon.

Cass Series

The Cass series consists of deep, well drained, moderately rapidly permeable soils on flood plains. These soils formed in noncalcareous, stratified, loamy and sandy alluvium. Slope ranges from 0 to 2 percent.

Typical pedon of Cass fine sandy loam, 1,220 feet west and 100 feet north of the southeast corner of sec. 13, T. 15 S., R. 6 W.

Ap—0 to 7 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; neutral; clear smooth boundary.

A—7 to 13 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; neutral; gradual smooth boundary.

AC—13 to 18 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) moist; moderate fine granular structure; slightly hard, friable; neutral; gradual smooth boundary.

C1—18 to 45 inches; brown (10YR 5/3) fine sandy loam, brown (10YR 4/3) moist; weak fine granular structure; soft, very friable; few strata of loamy fine sand; neutral; diffuse wavy boundary.

C2—45 to 60 inches; very pale brown (10YR 7/3) loamy fine sand, brown (10YR 5/3) moist; single grained; loose; few strata of loamy fine sand; neutral.

The solum is 16 to 20 inches thick. The mollic epipedon is 10 to 20 inches thick. The depth to free carbonates is more than 40 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is typically fine sandy loam, but in some pedons it is loam. It is medium acid to neutral. The C horizon has hue of 10YR, value of 5 to 7 (4 or 5 moist), and chroma of 2 or 3. It is typically fine sandy loam in the upper part and loamy fine sand in the lower part, but strata of more sandy or more loamy material are common. This horizon is slightly acid to moderately alkaline.

Crete Series

The Crete series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in loess. Slope ranges from 0 to 2 percent.

Crete soils are similar to Harney soils and are commonly adjacent to Geary soils. Geary soils have less clay in the subsoil than the Crete soils. They are on the lower side slopes. Harney soils have a mollic epipedon that is less than 20 inches thick. They are in positions on the landscape similar to those of the Crete soils.

Typical pedon of Crete silt loam, 0 to 2 percent slopes, 1,350 feet south and 100 feet west of the northeast corner of sec. 2, T. 15 S., R. 9 W.

Ap—0 to 7 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; common fine roots; slightly acid; abrupt smooth boundary.

AB—7 to 14 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate fine subangular blocky structure; slightly hard, friable; common fine roots; slightly acid; gradual smooth boundary.

Bt1—14 to 26 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; very hard, very firm; few fine roots; thin patchy clay films on faces of peds; neutral; gradual smooth boundary.

Bt2—26 to 34 inches; brown (10YR 4/3) silty clay, dark brown (10YR 3/3) moist; moderate medium blocky structure; very hard, very firm; few fine roots; thin patchy clay films on faces of peds; neutral; gradual smooth boundary.

BC—34 to 42 inches; brown (10YR 5/3) silty clay loam, brown (10YR 4/3) moist; moderate fine blocky structure; hard, firm; few fine roots; few fine concretions and soft accumulations of lime; mildly alkaline; gradual smooth boundary.

C—42 to 60 inches; pale brown (10YR 6/3) silty clay loam, brown (10YR 5/3) moist; few medium faint gray (10YR 5/1) and few fine distinct yellowish brown (10YR 5/6) mottles; massive; slightly hard, friable; common fine soft accumulations and threads of lime; moderately alkaline.

The thickness of the solum ranges from 30 to 50 inches. The depth to free carbonates ranges from 25 to 40 inches. The thickness of the mollic epipedon ranges from 20 to 36 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is silt loam or silty clay loam. It is medium acid or slightly acid. The Bt horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. It is slightly acid or neutral. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6 (4 or 5 moist), and chroma of 3 or 4. It is silt loam or silty clay loam and is mildly alkaline or moderately alkaline.

Edalgo Series

The Edalgo series consists of moderately deep, well drained, very slowly permeable soils on uplands. These soils formed in material weathered from noncalcareous shale. Slope ranges from 3 to 40 percent.

Edalgo soils are commonly adjacent to Harney, Hedville, and Wells soils. The deep Harney soils formed in calcareous loess on ridgetops and the upper side slopes. The shallow Hedville soils are on the steeper side slopes. The deep Wells soils are on side slopes below the Edalgo soils.

Typical pedon of Edalgo loam, 3 to 7 percent slopes, 1,950 feet west and 150 feet north of the southeast corner of sec. 36, T. 17 S., R. 7 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; common fine roots; medium acid; clear smooth boundary.

Bt1—8 to 14 inches; reddish brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) moist; moderate fine subangular blocky structure; hard, firm; common fine roots; thin patchy clay films on faces of peds; slightly acid; gradual smooth boundary.

Bt2—14 to 23 inches; reddish brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) moist; moderate medium blocky structure; very hard, very firm; common fine roots; thin patchy clay films on faces of peds; neutral; gradual wavy boundary.

C—23 to 34 inches; pink (5YR 8/3), red (2.5YR 5/6), and reddish brown (5YR 5/3) clay, pink (5YR 7/3), red (2.5YR 4/6), and reddish brown (5YR 4/3) moist; massive; very hard, very firm; few fine roots; few fine nearly white soft accumulations of lime; moderately alkaline; diffuse wavy boundary.

Cr—34 inches; multicolored, clayey shale.

The solum ranges from 17 to 34 inches in thickness. It is medium acid to neutral. The depth to weathered clayey shale ranges from 20 to 40 inches. The mollic epipedon is 8 to 16 inches thick.

The A horizon has hue of 10YR, value of 4 or 5 (3 moist), and chroma of 1 or 2. It is typically loam, but the range includes silt loam, silty clay loam, sandy clay loam, and clay loam. The Bt1 horizon has hue of 5YR to 2.5Y, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 4. It is clay or clay loam. The Bt2 horizon has hue of 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 4. The C horizon has hue of 2.5YR to 2.5Y, value of 4 to 8 (3 to 6 moist), and chroma of 1 to 8. It is clay or clay loam.

Geary Series

The Geary series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in loess. Slope ranges from 1 to 7 percent.

Geary soils are commonly adjacent to Harney and Wells soils. Harney soils have more clay in the subsoil than the Geary soils. They are on ridgetops and the upper side slopes. Wells soils have less clay in the subsoil than the Geary soils. They are in positions on the landscape similar to those of the Geary soils.

Typical pedon of Geary silt loam, 1 to 3 percent slopes, 2,240 feet north and 50 feet east of the southwest corner of sec. 29, T. 17 S., R. 10 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; many fine roots; medium acid; clear smooth boundary.

A—6 to 13 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; common fine roots; slightly acid; gradual smooth boundary.

Bt1—13 to 19 inches; brown (7.5YR 5/4) silty clay loam, dark brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; hard, firm; common fine

roots; thin patchy clay films on faces of peds; slightly acid; gradual smooth boundary.

Bt2—19 to 32 inches; light brown (7.5YR 6/4) silty clay loam, dark brown (7.5YR 4/4) moist, brown (7.5YR 5/4) rubbed and moist; moderate medium subangular blocky structure; hard, firm; few fine roots; thin patchy clay films on faces of peds; slightly acid; gradual smooth boundary.

BC—32 to 48 inches; light brown (7.5YR 6/4) silty clay loam, brown (7.5YR 5/4) moist; weak medium subangular blocky structure; hard, firm; neutral; diffuse smooth boundary.

C—48 to 60 inches; light brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) moist; massive; hard, friable; common fine accumulations of lime; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 30 to 60 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2. It is typically silt loam, but in some pedons it is silty clay loam. It is slightly acid or medium acid. The Bt horizon has hue of 7.5YR or 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 or 4. It is medium acid to mildly alkaline. The C horizon has hue of 7.5YR or 5YR, value of 5 to 7 (4 or 5 moist), and chroma of 4 to 6. It is clay loam or silty clay loam and is slightly acid to moderately alkaline.

Harney Series

The Harney series consists of deep, well drained, moderately slowly permeable soils on uplands. These soils formed in loess. Slope ranges from 1 to 6 percent.

Harney soils are similar to Crete soils and are commonly adjacent to Geary, Wakeen, and Wells soils. Crete soils have a mollic epipedon that is more than 20 inches thick. They are on the broader ridgetops. Geary and Wells soils have less clay in the subsoil than the Harney soils. They are on the lower side slopes. The moderately deep Wakeen soils are on side slopes below the Harney soils.

Typical pedon of Harney silt loam, 1 to 3 percent slopes, 700 feet east and 150 feet south of the northwest corner of sec. 12, T. 14 S., R. 9 W.

A—0 to 9 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, friable; many fine roots; neutral; clear smooth boundary.

AB—9 to 14 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; many fine roots; neutral; clear smooth boundary.

Bt—14 to 24 inches; brown (10YR 5/3) silty clay, dark brown (10YR 4/3) moist; moderate medium blocky structure; very hard, very firm; common roots; thin patchy clay films on faces of peds; neutral; gradual smooth boundary.

BCk—24 to 40 inches; pale brown (10YR 6/3) silty clay loam, yellowish brown (10YR 5/4) moist; moderate medium subangular blocky structure; very hard, firm; few roots; strong effervescence; mildly alkaline; few lime concretions; gradual smooth boundary.

C—40 to 60 inches; pale brown (10YR 6/3) silt loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, friable; mildly alkaline.

The thickness of the solum ranges from 26 to 50 inches. The depth to free carbonates ranges from 18 to 30 inches. The mollic epipedon ranges from 10 to 20 inches in thickness.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2. It is silt loam or silty clay loam and is medium acid to mildly alkaline. The Bt horizon has hue of 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 or 3. It is silty clay loam or silty clay and is slightly acid to moderately alkaline. The C horizon has hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 3 or 4. It is silt loam or silty clay loam.

Hedville Series

The Hedville series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in material weathered from noncalcareous sandstone. Slope ranges from 3 to 40 percent.

Hedville soils are commonly adjacent to the moderately deep Edalgo and Lancaster soils. Edalgo soils are on side slopes below the Hedville soils. Lancaster soils are on side slopes above the Hedville soils.

Typical pedon of Hedville loam, in an area of Lancaster-Hedville loams, 3 to 20 percent slopes, 2,310 feet east and 50 feet south of the northwest corner of sec. 24, T. 15 S., R. 7 S.

A—0 to 7 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, very friable; many fine roots; about 5 percent angular sandstone fragments 0.25 to 1.0 inch in size; slightly acid; gradual wavy boundary.

Bw—7 to 16 inches; brown (7.5YR 5/4) channery loam, dark brown (7.5YR 4/4) moist; weak fine granular structure; slightly hard, very friable; common fine roots; about 20 percent angular sandstone fragments 0.5 inch to 3.0 inches in size; medium acid; clear irregular boundary.

R—16 inches; brown sandstone.

The thickness of the solum and the depth to sandstone range from 4 to 20 inches. The solum is medium acid to neutral throughout.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is typically loam, but the range includes stony loam, fine sandy loam, and stony sandy loam. The content of coarse fragments in this horizon is less than 35 percent. The Bw horizon has properties similar to those of the A horizon, but it has hue of 10YR to 5YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 to 4.

Hord Series

The Hord series consists of deep, well drained, moderately permeable soils on stream terraces. These soils formed in mixed silty alluvium and loess. Slope ranges from 0 to 2 percent.

Hord soils are similar to McCook, Roxbury, and Tobin soils and are commonly adjacent to McCook and Roxbury soils. McCook and Roxbury soils are lower on the landscape than the Hord soils. They are calcareous within a depth of 15 inches. Tobin soils do not have a B horizon. They are along upland drainageways.

Typical pedon of Hord silt loam, rarely flooded, 450 feet north and 100 feet west of the southeast corner of sec. 19, T. 15 S., R. 8 W.

Ap—0 to 5 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; neutral; clear smooth boundary.

A—5 to 13 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; slightly acid; gradual smooth boundary.

Bw1—13 to 30 inches; brown (10YR 4/3) silt loam, dark brown (10YR 3/3) moist; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable; neutral; gradual smooth boundary.

Bw2—30 to 41 inches; brown (10YR 5/3) silt loam, dark brown (10YR 4/3) moist; moderate medium subangular blocky structure parting to moderate medium granular; slightly hard, friable; neutral; diffuse smooth boundary.

C—41 to 60 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; massive; soft, friable; slight effervescence; mildly alkaline.

The solum ranges from 24 to 48 inches in thickness. It is typically neutral or slightly acid but ranges from medium acid to mildly alkaline. The thickness of the mollic epipedon ranges from 20 to 40 inches. The depth to free carbonates ranges from 20 to 48 inches. Buried soil layers are common at a depth of more than 40 inches.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is typically silt loam, but in some pedons it is loam. The Bw horizon has hue of 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 or 3. It is typically silt loam, but in some pedons it is silty clay loam. The C horizon has hue of 10YR, value of 5 to 7 (3 to 5 moist), and chroma of 2 or 3. It is typically silt loam, but the range includes loam and silty clay loam.

Jansen Series

The Jansen series consists of deep, well drained soils on uplands. These soils formed in loamy sediments over alluvial sand and gravel. Permeability is moderate in the upper part of the profile and very rapid in the lower part. Slope ranges from 1 to 4 percent.

Jansen soils are commonly adjacent to Meadin and Wells soils. Meadin soils have gravelly coarse sand or sand at a depth of 8 to 20 inches. They are lower on the landscape than the Jansen soils. The loamy Wells soils are on side slopes below the Jansen soils.

Typical pedon of Jansen sandy loam, 1 to 4 percent slopes, 450 feet east and 525 feet south of the northwest corner of sec. 31, T. 15 S., R. 7 W.

Ap—0 to 5 inches; dark grayish brown (10YR 4/2) sandy loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, very friable; medium acid; abrupt smooth boundary.

A—5 to 13 inches; dark grayish brown (10YR 4/2) sandy loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; slightly hard, very friable; medium acid; clear smooth boundary.

Bt—13 to 28 inches; yellowish brown (10YR 5/4) sandy clay loam, dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure; slightly hard; friable; thin patchy clay films on faces of peds; slightly acid; clear wavy boundary.

2C1—28 to 33 inches; light yellowish brown (10YR 6/4) loamy coarse sand, dark yellowish brown (10YR 4/4) moist; weak fine subangular blocky structure; slightly hard, friable; medium acid; gradual wavy boundary.

2C2—33 to 60 inches; very pale brown (10YR 7/4) gravelly coarse sand; yellowish brown (10YR 5/4) moist; single grained; loose; slightly acid.

The thickness of the solum ranges from 20 to 36 inches and coincides with the depth to loamy coarse sand, coarse sand, or fine gravel. The mollic epipedon ranges from 10 to 20 inches in thickness. The solum has no carbonates. Reaction is strongly acid to neutral throughout the profile.

The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is sandy loam or loam. The Bt horizon has hue of 7.5YR or 10YR, value of 4 to 6 (3 or 4 moist), and chroma of 2 to 4. It is

sandy clay loam or clay loam. The 2C horizon has hue of 7.5YR or 10YR, value of 4 to 7 (3 to 5 moist), and chroma of 3 or 4. It is loamy coarse sand or gravelly coarse sand. The content of gravel in this horizon ranges from 15 to 35 percent. Some pedons have fine to coarse clay balls.

Lancaster Series

The Lancaster series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from noncalcareous sandstone and sandy shale. Slope ranges from 3 to 12 percent.

Lancaster soils are similar to Wells soils and are commonly adjacent to Edalgo, Harney, Hedville, and Wells soils. The deep Wells soils are on side slopes below the Lancaster soils. Edalgo soils have more clay in the subsoil than the Lancaster soils. They are in positions on the landscape similar to those of the Lancaster soils. The deep Harney soils are on side slopes above the Lancaster soils. The shallow Hedville soils are on the steeper side slopes.

Typical pedon of Lancaster loam, in an area of Lancaster-Hedville loams, 3 to 20 percent slopes, 660 feet east and 150 feet north of the southwest corner of sec. 4, T. 15 S., R. 6 W.

A—0 to 8 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; hard, friable; many fine roots; medium acid; clear smooth boundary.

AB—8 to 16 inches; brown (10YR 5/3) loam, dark brown (10YR 3/3) moist; moderate fine subangular blocky structure; hard, friable; many fine roots; about 5 percent rounded sandstone fragments 0.25 inch to 2.0 inches in diameter; medium acid; gradual smooth boundary.

Bt1—16 to 25 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; hard, firm; common fine roots; thin patchy clay films on faces of peds; about 5 percent rounded sandstone fragments 0.25 inch to 2.0 inches in diameter; slightly acid; gradual smooth boundary.

Bt2—25 to 32 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; weak fine subangular blocky structure; hard, firm; few fine roots; thin patchy clay films on faces of peds; about 10 percent rounded sandstone fragments 1 to 3 inches in diameter; neutral; clear wavy boundary.

Cr—32 inches; sandy shale.

The thickness of the solum ranges from 20 to 40 inches and coincides with the depth to sandstone or shale. Few fine fragments of sandstone are throughout the solum.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is typically loam, but in some pedons it is sandy loam. It is medium acid or slightly acid. The Bt horizon has hue of 10YR or 7.5YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 to 6. It is clay loam or sandy clay loam and is medium acid to neutral.

McCook Series

The McCook series consists of deep, well drained, moderately permeable soils on stream terraces and flood plains. These soils formed in calcareous alluvium. Slope ranges from 0 to 2 percent.

McCook soils are similar to Hord, Roxbury, and Tobin soils and are commonly adjacent to Hord and Roxbury soils. All of the similar soils have a mollic epipedon that is more than 20 inches thick. Hord soils are on higher stream terraces than the McCook soils. The rarely flooded Roxbury soils are lower on the landscape than the McCook soils or are in similar landscape positions. The occasionally flooded Roxbury and Tobin soils are on narrow flood plains along upland drainageways.

Typical pedon of McCook silt loam, 1,980 feet north and 2,300 feet west of the southeast corner of sec. 31, T. 14 S., R. 10 W.

Ap—0 to 6 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; slight effervescence; mildly alkaline; clear smooth boundary.

A—6 to 12 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; strong effervescence; moderately alkaline; gradual smooth boundary.

AC—12 to 22 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; slightly hard, friable; strong effervescence; moderately alkaline; gradual smooth boundary.

C1—22 to 37 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; massive; soft, very friable; few thin strata of more sandy material; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—37 to 60 inches; light gray (10YR 7/2) silt loam, grayish brown (10YR 5/2) moist; massive; soft, very friable; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 16 to 30 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches. Most pedons are calcareous to the surface, but some have no free carbonates in the upper 10 inches. Reaction is mildly alkaline or moderately alkaline throughout the profile.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is typically silt loam, but the range includes loam, silty clay loam, and very fine sandy loam. The AC horizon is silt loam or loam. The C horizon has hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 or 3. It is typically silt loam or very fine sandy loam, but the range includes loam. Thin strata of more sandy or more clayey material, buried soil layers, and faint mottles are below a depth of 30 inches in some pedons. Coarse sand or gravelly sand is below a depth of 40 inches in some pedons.

Meadin Series

The Meadin series consists of deep, excessively drained soils on uplands. These soils formed in loamy and sandy material over coarse sand and gravel. Permeability is moderate in the upper part of the profile and very rapid in the substratum. Slopes range from 3 to 15 percent.

Meadin soils are commonly adjacent to Jansen and Wells soils. Jansen soils are 20 to 36 inches deep over sand and gravel. They are on the less sloping parts of the landscape. Wells soils are 40 to 60 inches deep over sandstone and sandy shale. They are higher on the landscape than the Meadin soils.

Typical pedon of Meadin sandy loam, 3 to 15 percent slopes, 200 feet west and 125 feet north of the southeast corner of sec. 30, T. 15 S., R. 7 W.

A—0 to 7 inches; dark grayish brown (10YR 4/2) sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine and medium granular structure; slightly hard, very friable; about 10 percent fine and medium pebbles; slightly acid; gradual smooth boundary.

AC—7 to 14 inches; dark grayish brown (10YR 4/2) gravelly sandy loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; slightly hard, very friable; about 15 percent fine and medium pebbles as much as 15 millimeters in diameter; slightly acid; gradual wavy boundary.

2C—14 to 60 inches; very pale brown (10YR 7/4) gravelly coarse sand, light yellowish brown (10YR 6/4) moist; single grained; loose; about 35 percent pebbles as much as 30 millimeters in diameter; neutral.

The solum and the mollic epipedon range from 8 to 20 inches in thickness. The control section averages less than 35 percent gravel.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is sandy loam or loamy sand and is strongly acid to neutral. The 2C horizon has hue of 10YR or 7.5YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is a mixture of coarse sand and gravel and is slightly acid or neutral.

Nibson Series

The Nibson series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in material weathered from interbedded shale and chalky limestone. Slope ranges from 5 to 25 percent.

Nibson soils are commonly adjacent to Armo, Harney, and Wakeen soils. Armo and Harney soils are deep. Armo soils are on foot slopes, and Harney soils are on ridgetops. The moderately deep Wakeen soils are on the less sloping ridges above the Nibson soils.

Typical pedon of Nibson silt loam, in an area of Nibson-Wakeen silt loams, 5 to 25 percent slopes, 2 790 feet north and 100 feet east of the southwest corner of sec. 17, T. 16 S., R. 9 W.

A—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; slightly hard, friable; many fine roots; about 2 percent small limestone fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

Bw—8 to 14 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; moderate medium granular structure; slightly hard, friable; few fine roots; about 3 percent small limestone fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C—14 to 19 inches; very pale brown (10YR 8/3) silt loam, very pale brown (10YR 7/4) moist; weak medium granular structure; about 10 percent limestone fragments; violent effervescence; moderately alkaline; abrupt wavy boundary.

Cr—19 inches; interbedded shale and chalky limestone.

The depth to shale and chalky limestone ranges from 10 to 20 inches. The mollic epipedon is 7 to 10 inches thick.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is typically silt loam, but in some pedons it is loam. It is mildly alkaline to strongly alkaline. The Bw and C horizon are moderately alkaline or strongly alkaline. The Bw horizon has hue of 10YR, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is silty clay loam or silt loam. The C horizon has hue of 10YR, value of 6 to 8 (5 to 7 moist), and chroma of 2 to 4.

Roxbury Series

The Roxbury series consists of deep, well drained, moderately permeable soils on flood plains and terraces. These soils formed in calcareous, silty alluvium. Slope ranges from 0 to 2 percent.

Roxbury soils are similar to Hord, McCook, and Tobin soils and are commonly adjacent to Harney, Hord, and

McCook soils. Harney soils have more clay in the subsoil than the Roxbury soils. They are on uplands. Hord and Tobin soils have free carbonates at a depth of more than 15 inches. Hord soils are higher on the landscape than the Roxbury soils, and Tobin soils are on narrow flood plains along upland drainageways. McCook soils have a mollic epipedon that is less than 20 inches thick.

Typical pedon of Roxbury silt loam, 100 feet east and 50 feet north of the southwest corner of sec. 3, T. 15 S., R. 10 W.

A1—0 to 20 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak medium granular structure; slightly hard, friable; common fine roots; strong effervescence; mildly alkaline; gradual smooth boundary.

A2—20 to 32 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; few fine roots; strong effervescence; moderately alkaline; gradual smooth boundary.

C1—32 to 42 inches; grayish brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; massive; hard, friable; few fine roots; many fine pores; few films and fine threads of lime; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—42 to 60 inches; light brownish gray (10YR 6/2) silt loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, friable; thin strata of light gray (10YR 7/2) and grayish brown (10YR 5/2) loamy material; few films and threads of lime; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 25 to 50 inches. The mollic epipedon ranges from 20 to 40 inches in thickness and commonly extends below the A2 horizon. The depth to free carbonates is less than 15 inches. Reaction is mildly alkaline or moderately alkaline throughout the profile.

The A horizon has hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is silt loam or silty clay loam. The C horizon has hue of 10YR, value of 5 to 7 (4 or 5 moist), and chroma of 2 or 3. It is silt loam, silty clay loam, or loam. It is stratified with colors of higher and lower value and with various textures. Sandy or clayey strata are below a depth of 40 inches in some pedons.

Tobin Series

The Tobin series consists of deep, well drained, moderately permeable soils on narrow flood plains along upland drainageways. These soils formed in stratified, silty alluvium. Slope ranges from 0 to 2 percent.

Tobin soils are similar to Hord, McCook, and Roxbury soils and are commonly adjacent to Geary, Harney, and Hord soils. Hord soils have a B horizon and are not distinctly stratified in the lower part. They are on stream terraces. McCook and Roxbury soils have lime within a depth of 15 inches. They are lower on the landscape than the Tobin soils. Geary and Harney soils are on uplands. They are not subject to flooding.

Typical pedon of Tobin silt loam, occasionally flooded, 2,310 feet west and 60 feet south of the northeast corner of sec. 15, T. 14 S., R. 9 W.

A—0 to 20 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; slightly hard, friable; many fine roots; slightly acid; gradual smooth boundary.

AC—20 to 32 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; slightly hard, friable; common fine roots; mildly alkaline; diffuse smooth boundary.

C—32 to 60 inches; grayish brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; massive; slightly hard, very friable; few fine roots; strong effervescence; moderately alkaline.

The thickness of the solum ranges from 20 to 50 inches. The mollic epipedon ranges from 20 to 40 inches in thickness. The depth to free carbonates ranges from 15 to 40 inches.

The A, AC, and C horizons are typically silt loam, but the range includes loam and silty clay loam. The A and AC horizons have hue of 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. The A horizon is medium acid to neutral, and the AC horizon is neutral or mildly alkaline. The C horizon has hue of 10YR or 7.5YR, value of 5 or 6 (2 to 4 moist), and chroma of 1 to 3. It is mildly alkaline or moderately alkaline.

Wakeen Series

The Wakeen series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from chalky shale and limestone. Slope ranges from 2 to 20 percent.

Wakeen soils are commonly adjacent to Armo, Harney, and Nibson soils. The deep Armo soils are on side slopes below the Wakeen soils. Harney soils have more clay in the subsoil than the Wakeen soils. They are on ridges and the upper side slopes. The shallow Nibson soils are on the steeper side slopes.

Typical pedon of Wakeen silt loam, in an area of Nibson-Wakeen silt loams, 5 to 25 percent slopes, 1,225 feet west and 800 feet north of the southeast corner of sec. 3, T. 16 S., R. 10 W.

A—0 to 9 inches; dark gray (10YR 4/1) silt loam, very dark gray (10YR 3/1) moist; strong medium granular structure; slightly hard, friable; many fine roots; few

fine limestone fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Bw1—9 to 18 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; common roots; common fine and very fine limestone fragments; violent effervescence; moderately alkaline; gradual smooth boundary.

Bw2—18 to 30 inches; pale brown (10YR 6/3) silt loam, brown (10YR 5/3) moist; moderate fine granular structure; slightly hard, friable; few fine roots; many limestone fragments and chips; violent effervescence; moderately alkaline; gradual smooth boundary.

Cr—30 inches; white (10YR 8/2), soft chalky limestone.

The thickness of the solum and the depth to chalky limestone and shale range from 20 to 40 inches. The thickness of the mollic epipedon ranges from 7 to 20 inches. Secondary lime and soft chalk fragments make up less than 5 percent of the solum. The solum is mildly alkaline to strongly alkaline throughout. It is silt loam or silty clay loam.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. The Bw horizon has hue of 10YR, value of 5 to 7 (3 to 5 moist), and chroma of 2 or 3.

Wells Series

The Wells series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from sandstone and in old alluvium derived from sandstone and sandy shale. Slope ranges from 1 to 7 percent.

Wells soils are similar to Lancaster soils and are commonly adjacent to Harney, Hedville, and Lancaster soils. Harney soils have more clay in the subsoil than the Wells soils. They are on ridgetops and the upper side slopes. The shallow Hedville soils and the moderately deep Lancaster soils are on side slopes above the Wells soils.

Typical pedon of Wells loam, 3 to 7 percent slopes, 1,400 feet east and 75 feet south of the northwest corner of sec. 15, T. 14 S., R. 6 W.

A—0 to 11 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, very friable; many fine roots; slightly acid; clear smooth boundary.

Bt1—11 to 22 inches; brown (7.5YR 5/4) sandy clay loam, dark brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; hard, firm; many fine roots; thin patchy clay films on faces of peds; neutral; gradual smooth boundary.

Bt2—22 to 44 inches; yellowish red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; moderate medium subangular blocky structure; hard, firm; common fine roots; thin patchy clay films on faces of peds; neutral; gradual smooth boundary.

C—44 to 60 inches; reddish yellow (5YR 6/6) sandy loam, yellowish red (5YR 5/6) moist; massive; slightly hard, friable; slightly acid.

The thickness of the solum ranges from 35 to 55 inches. The mollic epipedon ranges from 10 to 20 inches in thickness. The depth to bedrock ranges from 40 to 60 inches.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. It is typically loam, but in some pedons it is sandy clay loam. It is medium acid or slightly acid. The Bt horizon has hue of 7.5YR or 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 to 6. It is clay loam or sandy clay loam and is medium acid to neutral. The C horizon has hue of 7.5YR or 5YR, value of 5 to 7 (5 or 6 moist), and chroma of 4 to 8. It is sandy loam, sandy clay loam, or clay loam and is slightly acid to mildly alkaline. In some pedons it has concretions of calcium carbonate.

Formation of the Soils

Soil forms through processes that act on deposited or accumulated geologic material. The characteristics of a soil at any given point are determined by the interaction of five factors of soil formation—climate, plants and other living organisms, parent material, relief, and time. Each of these factors influences the formation of every soil, and each modifies the effects of the other four. The relative effects of the individual factors vary from place to place. The interactions among the factors are more complex for some soils than for others.

Parent Material

Parent material is the unconsolidated material in which soils form. It either is material weathered from rocks through freezing and thawing, abrasion, erosion, or chemical processes or is weathered material deposited by wind or water. The parent material affects texture, structure, color, natural fertility, and many other soil properties. Soils differ partly because of the various kinds of parent material. The texture of the parent material influences the rate of the downward movement of water and air and thus greatly affects soil formation. The composition of the parent material largely determines the mineralogical composition of the soil and, hence, its natural fertility. The soils in Ellsworth County formed in recent alluvium, colluvium, loess, and material weathered from chalky limestone, shale, and sandstone.

Recent alluvium is sediment deposited by floodwater in stream valleys. Most of the alluvium in Ellsworth County is silty, but in a few areas it is loamy. Cass, McCook, Roxbury, and Tobin soils formed in alluvial material.

Colluvium is material that has accumulated at the base of the steeper slopes as a result of gravity. It weathered from chalky shale and limestone bedrock. Armo soils formed in loamy colluvial material.

Loess is silty, wind-deposited material, some of which was carried hundreds of miles from its source. Peorian Loess of the Wisconsin Glaciation, which covers many of the uplands in Ellsworth County, was deposited during the Pleistocene. In most places it is very pale brown or light gray and is calcareous and friable. Crete and Harney soils formed in this material. Geary soils formed in Loveland Loess, which was deposited during the Illinoian Glaciation.

The bedrock that crops out in Ellsworth County is chalky limestone, shale, or sandstone. The calcareous Nibson and Wakeen soils formed in material weathered from chalky limestone and shale of the Greenhorn Formation, which is a member of the Upper Cretaceous System. Edalgo, Hedville, and Lancaster soils formed in material weathered from shale and sandstone of the Dakota Formation, which is a member of the Lower Cretaceous System.

Climate

Climate is an active factor of soil formation. It directly influences soil formation by weathering the parent material. It indirectly affects soil formation through its effect on plants and animals. Soil-forming processes are most active when the soil is warm and moist.

The climate of Ellsworth County is typical continental. It is characterized by intermittent dry and moist periods, which can last for less than a year or for several years. The soil material dries to varying depths during dry periods. It slowly regains moisture during wet periods and can become so saturated that excess moisture penetrates the substratum. Because of the wetting and drying, some of the basic nutrients, and even clay particles, have been leached from the upper horizons in many soils. An accumulation of lime in the lower part of the subsoil in Harney soils is an indication of leaching by excess moisture. The downward movement of water is a major factor in transforming parent material into a soil that has distinct horizons.

Plant and Animal Life

Plants and animals have important effects on soil formation. Plants generally influence the content of nutrients and organic matter in the soil and the color of the surface layer. Earthworms, cicadas, and burrowing animals help to keep the soil open and porous. Bacteria and fungi help to decompose the plants, thus releasing plant nutrients.

Mid and tall prairie grasses have had the greatest influence on soil formation in Ellsworth County. As a result of the grasses, the upper part of a typical soil in the county is dark and is high in content of organic matter. In many areas the next layer is slightly finer textured and somewhat lighter colored than the layer above. The underlying parent material generally is light in color. The soils that formed under a canopy of oaks in

the eastern part of the county do not have a thick, dark surface layer and are more acid than the soils that formed under prairie grasses.

Human activities have greatly affected soil formation. In most areas they have increased the susceptibility to erosion, increased or decreased the organic matter content, or changed the relief through land leveling and through industrial and urban development.

Relief

Relief, or lay of the land, influences the formation of soils through its effect on drainage, runoff, plant cover, and soil temperature. Although climate and plants are the most active factors of soil formation, relief also is important, mainly because it controls the movement of water on the surface and into the soil.

Runoff is more rapid on the steeper upland soils than on the less sloping soils. As a result, erosion is more extensive. Hedville soils formed in old parent material, but relief has restricted their formation. Runoff is rapid on these moderately sloping to steep soils, and much of the soil material is removed as soon as a soil profile forms.

Time

The length of time needed for soil formation depends largely on the other factors of soil formation. As water moves downward through the soil, soluble material and fine particles are gradually leached from the surface layer to the subsoil. The amount of leaching depends on the amount of time that has elapsed and the amount of water that has penetrated the surface.

Differences in the length of time that the parent material has been exposed to the processes of soil formation are reflected in the degree of profile development. For example, the young McCook soils, which formed in recent alluvium, show very little evidence of horizon development other than a slight darkening of the surface layer. In contrast, the older Crete and Geary soils, which have been exposed to soil-forming processes for thousands of years, have well defined horizons.

References

(1) American Association of State Highway and Transportation Officials. 1982. Standard specifications for highway materials and methods of sampling and testing. Ed. 13, 2 vols., illus.

(2) American Society for Testing and Materials. 1985. Standard test method for classification of soils for engineering purposes. ASTM Stand. D 2487.

(3) Kansas State Board of Agriculture. 1981. 1980-1981 farm facts. Spec. Rep. Kans. Crop and Kans. Cattle Mark. Stat., 276 pp., illus.

(4) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus.

(5) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

Glossary

ABC soil. A soil having an A, a B, and a C horizon.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Argillic horizon. A subsoil horizon characterized by an accumulation of illuvial clay.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity, but is more precise in meaning.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.
Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:
Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.
Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Mollic epipedon. A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Root zone. The part of the soil that can be penetrated by plant roots.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multipled by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from about 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1941-70 at Ellsworth, Kansas)

Month	Temperature					Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	In	In	In		In
January----	42.0	17.5	29.8	70	-15	0.67	0.10	0.95	1	5.1
February---	47.2	22.0	34.6	80	-7	.97	.11	1.65	2	6.0
March------	55.2	28.7	42.0	86	-1	1.71	.46	2.87	3	4.8
April------	69.2	41.7	55.5	92	18	2.52	1.22	3.98	5	.6
May--------	78.2	52.3	65.3	99	29	3.81	2.05	6.62	7	.0
June-------	87.9	62.6	75.3	104	42	4.37	2.14	6.29	6	.0
July-------	93.4	67.5	80.5	107	49	3.62	1.52	5.98	6	.0
August-----	92.6	66.3	79.5	108	49	3.02	1.69	4.57	5	.0
September--	82.9	56.1	69.5	104	35	3.47	1.36	4.98	5	.0
October----	72.3	44.9	58.6	96	22	2.08	.51	3.76	3	.3
November---	56.2	30.3	43.5	78	4	.95	.06	2.26	2	1.9
December---	44.4	20.9	32.7	71	-9	.90	.19	1.48	2	4.8
Year-----	68.5	42.6	55.6	108	-17	28.09	20.75	32.82	47	23.5

TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Temperature		
	24^{o} F or lower	28^{o} F or lower	32^{o} F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 14	Apr. 26	May 7
2 years in 10 later than--	Apr. 9	Apr. 21	May 2
5 years in 10 later than--	Mar. 31	Apr. 11	Apr. 22
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 22	Oct. 14	Oct. 4
2 years in 10 earlier than--	Oct. 26	Oct. 19	Oct. 8
5 years in 10 earlier than--	Nov. 5	Oct. 28	Oct. 18

TABLE 3.--GROWING SEASON

Probability	Daily minimum temperature during growing season		
	Higher than 24^{o} F	Higher than 28^{o} F	Higher than 32^{o} F
	Days	Days	Days
9 years in 10	201	180	158
8 years in 10	207	187	165
5 years in 10	219	200	179
2 years in 10	231	213	192
1 year in 10	237	219	199

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Ar	Armo loam, 3 to 7 percent slopes	17,450	3.8
Au	Armo loam, 7 to 15 percent slopes	13,880	3.0
Cb	Cass fine sandy loam	710	0.2
Cd	Crete silt loam, 0 to 2 percent slopes	53,430	11.5
Ed	Edalgo loam, 3 to 7 percent slopes	2,920	0.6
Eh	Edalgo-Hedville loams, 7 to 15 percent slopes	25,180	5.4
Ev	Edalgo-Hedville loams, 15 to 40 percent slopes	5,060	1.1
Gb	Geary silt loam, 1 to 3 percent slopes	3,650	0.8
Gc	Geary silt loam, 3 to 7 percent slopes	3,930	0.8
Hb	Harney silt loam, 1 to 3 percent slopes	72,120	15.7
He	Harney-Wakeen complex, 2 to 6 percent slopes	13,810	3.0
Hm	Harney-Wells complex, 2 to 6 percent slopes	47,860	10.3
Ho	Hord silt loam, nonflooded	1,910	0.4
Hr	Hord silt loam, rarely flooded	1,950	0.4
Jc	Jansen sandy loam, 1 to 4 percent slopes	6,470	1.4
Lh	Lancaster-Hedville loams, 3 to 20 percent slopes	79,680	17.3
Mb	McCook loam, occasionally flooded	760	0.2
Mc	McCook silt loam	6,110	1.3
Mf	McCook silty clay loam, frequently flooded	1,660	0.4
Mn	Meadin sandy loam, 3 to 15 percent slopes	6,510	1.4
Nw	Nibson-Wakeen silt loams, 5 to 25 percent slopes	13,660	3.0
Rb	Roxbury silt loam	3,410	0.7
Rf	Roxbury silt loam, occasionally flooded	6,660	1.4
To	Tobin silt loam, occasionally flooded	29,480	6.4
Wr	Wells loam, 1 to 3 percent slopes	13,950	3.0
Ws	Wells loam, 3 to 7 percent slopes	26,130	5.6
	Water	4,367	0.9
	Total	462,707	100.0

TABLE 5.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Land capability	Winter wheat*	Grain sorghum	Alfalfa hay
		Bu	Bu	Tons
Ar------------------------ Armo	IIIe	30	45	---
Au------------------------ Armo	VIe	---	---	---
Cb------------------------ Cass	IIw	37	57	4.0
Cd------------------------ Crete	IIs	34	53	3.2
Ed------------------------ Edalgo	IVe	26	41	---
Eh------------------------ Edalgo-Hedville	VIe	---	---	---
Ev------------------------ Edalgo-Hedville	VIIe	---	---	---
Gb------------------------ Geary	IIe	35	55	4.0
Gc------------------------ Geary	IIIe	33	51	3.6
Hb------------------------ Harney	IIe	34	53	2.8
He------------------------ Harney-Wakeen	IVe	30	46	2.5
Hm------------------------ Harney-Wells	IIIe	31	49	3.0
Ho, Hr-------------------- Hord	I	41	64	4.2
Jc------------------------ Jansen	IIIe	31	49	1.6
Lh------------------------ Lancaster-Hedville	VIe	---	---	---
Mb------------------------ McCook	IIw	36	54	3.0
Mc------------------------ McCook	I	36	54	3.5
Mf------------------------ McCook	Vw	---	---	---
Mn------------------------ Meadin	VIs	---	---	---
Nw------------------------ Nibson-Wakeen	VIe	---	---	---

See footnote at end of table.

TABLE 5.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Land capability	Winter wheat*	Grain sorghum	Alfalfa hay
		Bu	Bu	Tons
Rb-------------------------- Roxbury	I	38	56	4.2
Rf-------------------------- Roxbury	IIw	38	56	3.5
To-------------------------- Tobin	IIw	41	64	---
Wr-------------------------- Wells	IIe	35	55	4.0
Ws-------------------------- Wells	IIIe	32	50	3.6

* Yields are for wheat grown year after year and for wheat following fallow.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

(Only the soils that support rangeland vegetation suitable for grazing are listed)

Soil name and map symbol	Range site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Ar, Au: Armo	Limy Upland	Favorable	4,500	Big bluestem	40
		Normal	3,000	Little bluestem	20
		Unfavorable	2,000	Sideoats grama	10
				Indiangrass	5
				Switchgrass	5
				Western wheatgrass	5
Cb: Cass	Sandy Lowland	Favorable	5,500	Sand bluestem	30
		Normal	4,000	Little bluestem	25
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Prairie sandreed	5
Cd: Crete	Clay Upland	Favorable	5,000	Big bluestem	30
		Normal	3,500	Little bluestem	15
		Unfavorable	2,000	Switchgrass	10
				Sideoats grama	10
				Indiangrass	5
				Western wheatgrass	5
				Tall dropseed	5
Ed: Edalgo	Clay Upland	Favorable	4,500	Big bluestem	30
		Normal	3,000	Little bluestem	15
		Unfavorable	2,000	Switchgrass	15
				Indiangrass	10
				Tall dropseed	5
				Sideoats grama	5
Eh*, Ev*:					
Edalgo	Clay Upland	Favorable	4,500	Big bluestem	30
		Normal	3,000	Little bluestem	15
		Unfavorable	2,000	Switchgrass	15
				Indiangrass	10
				Tall dropseed	5
				Sideoats grama	5
Hedville	Shallow Sandstone	Favorable	4,000	Little bluestem	35
		Normal	3,000	Big bluestem	30
		Unfavorable	2,000	Switchgrass	5
				Indiangrass	5
				Sideoats grama	5
Gb, Gc: Geary	Loamy Upland	Favorable	5,500	Big bluestem	30
		Normal	4,000	Little bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
				Sideoats grama	10
				Tall dropseed	5
Hb: Harney	Loamy Upland	Favorable	5,000	Big bluestem	25
		Normal	3,500	Little bluestem	20
		Unfavorable	2,000	Sideoats grama	15
				Western wheatgrass	10
				Blue grama	5
He*:					
Harney	Loamy Upland	Favorable	5,000	Big bluestem	25
		Normal	3,500	Little bluestem	20
		Unfavorable	2,000	Sideoats grama	15
				Western wheatgrass	10
				Blue grama	5

See footnote at end of table.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
He*:					
Wakeen	Limy Upland	Favorable	4,500	Big bluestem	35
		Normal	2,500	Little bluestem	20
		Unfavorable	2,000	Sideoats grama	15
				Switchgrass	5
				Blue grama	5
Hm*:					
Harney	Loamy Upland	Favorable	5,000	Big bluestem	25
		Normal	3,500	Little bluestem	20
		Unfavorable	2,000	Sideoats grama	15
				Western wheatgrass	10
				Blue grama	5
Wells	Loamy Upland	Favorable	5,500	Big bluestem	30
		Normal	4,000	Little bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
				Sideoats grama	10
Ho Hord	Loamy Terrace	Favorable	6,000	Big bluestem	30
		Normal	4,500	Little bluestem	10
		Unfavorable	3,300	Indiangrass	10
				Switchgrass	10
				Blue grama	5
				Western wheatgrass	5
				Sideoats grama	5
Hr Hord	Loamy Terrace	Favorable	6,000	Big bluestem	30
		Normal	4,500	Little bluestem	10
		Unfavorable	3,000	Switchgrass	10
				Indiangrass	10
				Western wheatgrass	5
				Sideoats grama	5
				Blue grama	5
Jc Jansen	Sandy	Favorable	3,700	Sand bluestem	25
		Normal	3,200	Little bluestem	20
		Unfavorable	2,700	Switchgrass	10
				Big bluestem	10
				Indiangrass	10
				Sand lovegrass	5
Lh*:					
Lancaster	Loamy Upland	Favorable	5,000	Big bluestem	30
		Normal	3,500	Little bluestem	25
		Unfavorable	2,000	Indiangrass	10
				Sideoats grama	10
				Switchgrass	5
Hedville	Shallow Sandstone	Favorable	4,000	Little bluestem	35
		Normal	3,000	Big bluestem	30
		Unfavorable	2,000	Switchgrass	5
				Indiangrass	5
				Sideoats grama	5
Mb McCook	Loamy Lowland	Favorable	6,500	Big bluestem	30
		Normal	4,500	Eastern gamagrass	10
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Western wheatgrass	5
				Little bluestem	5
				Sedge	5

See footnote at end of tables.

TABLE 6.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Mc: McCook	Loamy Terrace	Favorable	6,000	Big bluestem	30
		Noraml	4,500	Little bluestem	10
		Unfavorable	3,000	Switchgrass	10
				Indiangrass	10
				Western wheatgrass	5
				Sideoats grama	5
				Sedge	5
Mn: Meadin	Sandy	Favorable	2,100	Sand bluestem	25
		Normal	1,600	Little bluestem	20
		Unfavorable	1,200	Big bluestem	10
				Switchgrass	10
				Indiangrass	10
				Sand lovegrass	5
				Blue grama	5
				Hairy grama	5
				Tall dropseed	5
Nw*:					
Nibson	Limy Upland	Favorable	4,500	Big bluestem	35
		Normal	2,500	Little bluestem	20
		Unfavorable	1,500	Sideoats grama	15
				Indiangrass	5
				Blue grama	5
				Western wheatgrass	5
Wakeen	Limy Upland	Favorable	4,500	Big bluestem	35
		Normal	2,500	Little bluestem	20
		Unfavorable	2,000	Sideoats grama	15
				Switchgrass	5
				Blue grama	5
Rb: Roxbury	Loamy Terrace	Favorable	6,000	Big bluestem	35
		Normal	4,500	Sideoats grama	15
		Unfavorable	3,000	Western wheatgrass	15
				Switchgrass	10
				Little bluestem	10
				Indiangrass	5
Rf: Roxbury	Loamy Lowland	Favorable	6,500	Big bluestem	40
		Normal	5,500	Switchgrass	10
		Unfavorable	4,000	Indiangrass	10
				Western wheatgrass	10
				Little bluestem	5
				Prairie cordgrass	5
				Eastern gamagrass	5
To: Tobin	Loamy Lowland	Favorable	6,500	Big bluestem	40
		Normal	5,500	Indiangrass	10
		Unfavorable	4,000	Switchgrass	10
				Eastern gamagrass	10
				Little bluestem	5
				Western wheatgrass	5
				Sedge	5
				Prairie cordgrass	5
Wr, Ws: Wells	Loamy Upland	Favorable	5,500	Big bluestem	30
		Normal	4,000	Little bluestem	20
		Unfavorable	2,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	10
				Tall dropseed	5

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
Ar, Au: Armo	Fragrant sumac, Siberian peashrub, silver buffaloberry, Tatarian honeysuckle.	Eastern redcedar, bur oak, Russian-olive, Rocky Mountain juniper.	Ponderosa pine, honeylocust, green ash, Siberian elm.	---	---
Cb: Cass	---	Peking cotoneaster, Amur honeysuckle, lilac, American plum.	Eastern redcedar	Austrian pine, hackberry, ponderosa pine, honeylocust, bur oak, green ash.	Eastern cottonwood.
Cd: Crete	Lilac, Peking cotoneaster, Amur honeysuckle, Siberian peashrub.	Manchurian crabapple.	Eastern redcedar, hackberry, Russian-olive, green ash, Austrian pine, honeylocust.	Siberian elm	---
Ed: Edalgo	Siberian peashrub, Amur honeysuckle, Peking cotoneaster.	Eastern redcedar, Rocky Mountain juniper, hackberry.	Austrian pine, honeylocust, Russian-olive, green ash, Russian mulberry.	Siberian elm	---
Eh*:					
Edalgo	Siberian peashrub, Amur honeysuckle, Peking cotoneaster.	Eastern redcedar, Rocky Mountain juniper, hackberry.	Austrian pine, honeylocust, Russian-olive, green ash, Russian mulberry.	Siberian elm	---
Hedville.					
Ev*:					
Edalgo.					
Hedville.					
Gb, Gc: Geary	Peking cotoneaster	Lilac, fragrant sumac, Amur honeysuckle.	Eastern redcedar, hackberry, bur oak, green ash, Russian-olive.	Scotch pine, Austrian pine, honeylocust.	---
Hb: Harney	Amur honeysuckle, lilac, fragrant sumac.	Russian mulberry	Eastern redcedar, bur oak, honeylocust, Russian-olive, Austrian pine, green ash, hackberry.	Siberian elm	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
He*:					
Harney	Amur honeysuckle, lilac, fragrant sumac.	Russian mulberry	Eastern redcedar, bur oak, honeylocust, Russian-olive, Austrian pine, green ash, hackberry.	Siberian elm	---
Wakeen	Siberian peashrub, fragrant sumac, silver buffaloberry, Tatarian honeysuckle.	Eastern redcedar, Russian-olive, Rocky Mountain juniper, bur oak.	Honeylocust, Siberian elm, ponderosa pine, green ash.	---	---
Hm*:					
Harney	Amur honeysuckle, lilac, fragrant sumac.	Russian mulberry	Eastern redcedar, bur oak, honeylocust, Russian-olive, Austrian pine, green ash, hackberry.	Siberian elm	---
Wells	Peking cotoneaster	Fragrant sumac, Amur honeysuckle, lilac.	Russian-olive, eastern redcedar, hackberry, bur oak, green ash.	Austrian pine, Scotch pine, honeylocust.	---
Ho: Hord	---	Siberian peashrub, American plum, lilac.	Ponderosa pine, hackberry, blue spruce, bur oak, Russian-olive, eastern redcedar.	Green ash, honeylocust.	Eastern cottonwood.
Hr: Hord	Peking cotoneaster	Lilac, Siberian peashrub, American plum.	Eastern redcedar, ponderosa pine, blue spruce, Manchurian crabapple.	Golden willow, green ash, hackberry.	Eastern cottonwood.
Jc: Jansen	Siberian peashrub, Peking cotoneaster, lilac.	Eastern redcedar, Russian-olive, ponderosa pine, Manchurian crabapple, Rocky Mountain juniper, bur oak.	Green ash, Siberian elm, honeylocust.	---	---
Lh*:					
Lancaster	Fragrant sumac, lilac, Siberian peashrub.	Rocky Mountain juniper, Russian mulberry, Russian-olive.	Eastern redcedar, green ash, Austrian pine, bur oak, honeylocust.	Siberian elm	---
Hedville.					

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
Mb-----------------McCook	American plum, lilac.	Tatarian honeysuckle.	Eastern redcedar, ponderosa pine, Russian-olive, hackberry, green ash, Rocky Mountain juniper.	Honeylocust, Siberian elm.	Eastern cottonwood.
Mc-----------------McCook	American plum, lilac.	Tatarian honeysuckle.	Eastern redcedar, ponderosa pine, hackberry, green ash, Russian-olive, Rocky Mountain juniper.	Honeylocust, Siberian elm.	Eastern cottonwood.
Mf. McCook					
Mn. Meadin					
Nw*: Nibson.					
Wakeen------------	Siberian peashrub, fragrant sumac, silver buffaloberry, Tatarian honeysuckle.	Eastern redcedar, Russian-olive, Rocky Mountain juniper, bur oak.	Honeylocust, Siberian elm, ponderosa pine, green ash.	---	---
Rb-----------------Roxbury	American plum, lilac.	Amur honeysuckle	Russian mulberry, ponderosa pine, green ash, Russian-olive, eastern redcedar.	Hackberry, honeylocust, Siberian elm.	Eastern cottonwood.
Rf-----------------Roxbury	American plum, lilac.	Amur honeysuckle	Eastern redcedar, Russian-olive, ponderosa pine, green ash, Russian mulberry.	Hackberry, honeylocust, Siberian elm.	Eastern cottonwood.
To-----------------Tobin	American plum-----	Lilac, Amur honeysuckle.	Eastern redcedar, Russian-olive, Austrian pine, green ash, ponderosa pine, Russian mulberry.	Hackberry, honeylocust.	Eastern cottonwood.
Wr, Ws-------------Wells	Peking cotoneaster	Fragrant sumac, Amur honeysuckle, lilac.	Russian-olive, eastern redcedar, hackberry, bur oak, green ash.	Austrian pine, Scotch pine, honeylocust.	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe")

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ar: Armo	Slight	Slight	Moderate: slope.	Slight.
Au: Armo	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Cb: Cass	Severe: flooding.	Slight	Moderate: flooding.	Slight.
Cd: Crete	Slight	Slight	Slight	Slight.
Ed: Edalgo	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, small stones, depth to rock.	Slight.
Eh*:				
Edalgo	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Severe: erodes easily.
Hedville	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, small stones.	Slight.
Ev*:				
Edalgo	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, erodes easily.
Hedville	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, small stones.	Moderate: slope.
Gb, Gc: Geary	Slight	Slight	Moderate: slope.	Slight.
Hb: Harney	Slight	Slight	Moderate: slope.	Slight.
He*:				
Harney	Slight	Slight	Moderate: slope.	Slight.
Wakeen	Slight	Slight	Moderate: slope, depth to rock.	Slight.
Hm*:				
Harney	Slight	Slight	Moderate: slope.	Slight.
Wells	Slight	Slight	Moderate: slope.	Slight.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ho------------------- Hord	Slight---------------	Slight---------------	Slight---------------	Slight.
Hr------------------- Hord	Severe: flooding.	Slight---------------	Slight---------------	Slight.
Jc------------------- Jansen	Slight---------------	Slight---------------	Moderate: slope.	Slight.
Lh*:				
Lancaster------------	Slight---------------	Slight---------------	Severe: slope.	Slight.
Hedville-------------	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, small stones.	Slight.
Mb------------------- McCook	Severe: flooding.	Slight---------------	Moderate: flooding.	Slight.
Mc------------------- McCook	Severe: flooding.	Slight---------------	Slight---------------	Slight.
Mf------------------- McCook	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.
Mn------------------- Meadin	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Nw*:				
Nibson---------------	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Moderate: slope.
Wakeen---------------	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Rb------------------- Roxbury	Severe: flooding.	Slight---------------	Slight---------------	Slight.
Rf------------------- Roxbury	Severe: flooding.	Slight---------------	Moderate: flooding.	Slight.
To------------------- Tobin	Severe: flooding.	Slight---------------	Moderate: flooding.	Slight.
Wr, Ws--------------- Wells	Slight---------------	Slight---------------	Moderate: slope.	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.-WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Ar: Armo	Fair	Good	Good	---	---	Fair	Poor	Very poor.	Good	---	Very poor.	Fair.
Au: Armo	Poor	Fair	Good	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Cb: Cass	Good	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
Cd: Crete	Good	Good	Good	Fair	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.	Good.
Ed: Edalgo	Good	Good	Good	---	---	Fair	Very poor.	Very poor.	Good	---	Very poor.	Good.
Eh*, Ev*:												
Edalgo	Fair	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Hedville	Very poor.	Poor	Fair	---	---	Fair	Very poor.	Very poor.	Poor	---	Very poor.	Fair.
Gb: Geary	Good	Good	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor	Good.
Gc: Geary	Fair	Good	Good	Fair	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.	Good.
Hb: Harney	Good	Good	Good	Poor	Poor	Good	Poor	Fair	Good	---	Poor	Good.
He*:												
Harney	Fair	Good	Fair	Poor	Poor	Fair	Poor	Poor	Fair	---	Poor	Fair.
Wakeen	Fair	Good	Fair	---	---	Poor	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Hm*:												
Harney	Fair	Good	Fair	Poor	Poor	Fair	Poor	Poor	Fair	---	Poor	Fair.
Wells	Good	Good	Good	---	---	Fair	Very poor.	Very poor.	Good	---	Very poor.	Fair.
Ho, Hr: Hord	Good	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
Jc: Jansen	Fair	Good	Good	Fair	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.	Fair.
Lh*:												
Lancaster	Fair	Good	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Hedville	Very poor.	Poor	Fair	---	---	Fair	Very poor.	Very poor.	Poor	---	Very poor.	Fair.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Mb, Mc-------------- McCook	Good	Good	Good	Good	Fair	Good	Very poor.	Very poor.	Good	Fair	Very poor.	Good.
Mf------------------ McCook	Poor	Poor	Fair	Good	Fair	Good	Very poor.	Very poor.	Poor	Fair	Very poor.	Good.
Mn------------------ Meadin	Very poor.	Poor	Fair	Poor	Poor	Fair	Very poor.	Very poor.	Poor	Poor	Very poor.	Fair.
Nw*: Nibson------------	Poor	Fair	Fair	Very poor.	Very poor.	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Wakeen------------	Poor	Fair	Fair	---	---	Poor	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Rb, Rf-------------- Roxbury	Good	Good	Good	Fair	Fair	Fair	Poor	Fair	Good	Fair	Poor	Fair.
To------------------ Tobin	Good	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor	Good.
Wr, Ws-------------- Wells	Good	Good	Good	---	---	Fair	Very poor.	Very poor.	Good	---	Very poor.	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Ar: Armo	Slight	Slight	Slight	Moderate: slope.	Severe: low strength.
Au: Armo	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: low strength.
Cb: Cass	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Cd: Crete	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Ed: Edalgo	Moderate: depth to rock, too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Eh*:					
Edalgo	Moderate: depth to rock, too clayey, slope.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.
Hedville	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.
Ev*:					
Edalgo	Severe: slope.	Severe: shrink-swell, slope.	Severe: slope, shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, slope, shrink-swell.
Hedville	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.
Gb: Geary	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.
Gc: Geary	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.
Hb: Harney	Moderate: too clayey.	Moderate: shrink-swell.	Slight	Moderate: shrink-swell.	Severe: low strength.
He*:					
Harney	Moderate: too clayey.	Moderate: shrink-swell.	Slight	Moderate: shrink-swell, slope.	Severe: low strength.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
He*:					
Wakeen	Moderate: depth to rock.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Hm*:					
Harney	Moderate: too clayey.	Moderate: shrink-swell.	Slight	Moderate: shrink-swell, slope.	Severe: low strength.
Wells	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.
Ho Hord	Slight	Slight	Slight	Slight	Severe: low strength.
Hr Hord	Slight	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength.
Jc Jansen	Severe: cutbanks cave.	Moderate: shrink-swell.	Slight	Moderate: shrink-swell.	Severe: low strength.
Lh*:					
Lancaster	Moderate: depth to rock.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.
Hedville	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.
Mb McCook	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Mc McCook	Slight	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding, frost action.
Mf McCook	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Mn Meadin	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Nw*:					
Nibson	Severe: depth to rock, slope.	Severe: slope.	Severe: depth to rock, slope.	Severe: slope.	Severe: low strength, slope.
Wakeen	Moderate: depth to rock, slope.	Moderate: shrink-swell, slope.	Moderate: depth to rock, slope, shrink-swell.	Severe: slope.	Severe: low strength.
Rb Roxbury	Slight	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength.
Rf Roxbury	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
To----------------- Tobin	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.
Wr----------------- Wells	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Ws----------------- Wells	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ar----------------- Armo	Slight-----------	Moderate: seepage, slope.	Slight-----------	Slight-----------	Fair: too clayey, thin layer.
Au----------------- Armo	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: too clayey, slope, thin layer.
Cb----------------- Cass	Severe: flooding.	Severe: seepage, flooding.	Severe: flooding, seepage.	Severe: flooding, seepage.	Fair: thin layer.
Cd----------------- Crete	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight-----------	Poor: hard to pack.
Ed----------------- Edalgo	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: depth to rock, too clayey, hard to pack.
Eh*:					
Edalgo-------------	Severe: depth to rock, percs slowly.	Severe: depth to rock, slope.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: depth to rock, too clayey, hard to pack.
Hedville-----------	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: depth to rock.
Ev*:					
Edalgo-------------	Severe: depth to rock, percs slowly, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope, too clayey.	Severe: depth to rock, slope.	Poor: depth to rock, too clayey, hard to pack.
Hedville-----------	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: depth to rock, slope.
Gb, Gc------------- Geary	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
Hb----------------- Harney	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
He*:					
Harney-------------	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
He*:					
Wakeen	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Poor: depth to rock.
Hm*:					
Harney	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Wells	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Ho Hord	Slight	Moderate: seepage.	Slight	Slight	Good.
Hr Hord	Moderate: flooding.	Moderate: seepage.	Moderate: flooding.	Moderate: flooding.	Good.
Jc Jansen	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Lh*:					
Lancaster	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: depth to rock.
Hedville	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: depth to rock.
Mb McCook	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Good.
Mc McCook	Moderate: flooding, percs slowly.	Moderate: seepage.	Moderate: flooding.	Moderate: flooding.	Good.
Mf McCook	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Good.
Mn Meadin	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Nw*:					
Nibson	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: depth to rock, slope.
Wakeen	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: depth to rock.
Rb Roxbury	Moderate: flooding.	Moderate: seepage.	Moderate: flooding, too clayey.	Moderate: flooding.	Fair: too clayey.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Rf------------------ Roxbury	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
To------------------ Tobin	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
Wr, Ws-------------- Wells	Slight-----------	Moderate: seepage, slope.	Moderate: too clayey.	Slight-----------	Fair: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ar, Au: Armo	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
Cb: Cass	Good	Probable	Improbable: too sandy.	Good.
Cd: Crete	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Ed: Edalgo	Poor: depth to rock, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Eh*:				
Edalgo	Poor: depth to rock, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Hedville	Poor: depth to rock.	Improbable: excess fines.	Improbable: excess fines.	Poor: depth to rock, small stones.
Ev*:				
Edalgo	Poor: depth to rock, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, slope.
Hedville	Poor: depth to rock.	Improbable: excess fines.	Improbable: excess fines.	Poor: depth to rock, small stones, slope.
Gb, Gc: Geary	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Hb: Harney	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
He*:				
Harney	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Wakeen	Poor: depth to rock, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: depth to rock.
Hm*:				
Harney	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Hm*:				
Wells	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Ho, Hr Hord	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Jc Jansen	Good	Probable	Improbable: too sandy.	Poor: area reclaim.
Lh*:				
Lancaster	Poor: depth to rock.	Improbable: excess fines.	Improbable: excess fines.	Fair: depth to rock, small stones, thin layer.
Hedville	Poor: depth to rock.	Improbable: excess fines.	Improbable: excess fines.	Poor: depth to rock, small stones.
Mb, Mc, Mf McCook	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Mn Meadin	Good	Probable	Probable	Poor: too sandy, small stones, area reclaim.
Nw*:				
Nibson	Poor: depth to rock, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: depth to rock, small stones, slope.
Wakeen	Poor: depth to rock, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: depth to rock, slope.
Rb, Rf Roxbury	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
To Tobin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Wr, Ws Wells	Good	Improbable: excess fines.	Improbable: excess fines.	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
Ar: Armo	Moderate: seepage, slope.	Moderate: thin layer, piping.	Deep to water	Slope	Favorable	Favorable.
Au: Armo	Severe: slope.	Moderate: thin layer, piping.	Deep to water	Slope	Slope	Slope.
Cb: Cass	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, flooding.	Soil blowing	Favorable.
Cd: Crete	Moderate: seepage.	Moderate: hard to pack.	Deep to water	Percs slowly, erodes easily.	Erodes easily	Erodes easily, percs slowly.
Ed: Edalgo	Moderate: depth to rock, slope.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly, depth to rock, slope.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Eh*, Ev*:						
Edalgo	Severe: slope.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly, depth to rock, slope.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
Hedville	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Slope, depth to rock.	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.
Gb: Geary	Moderate: seepage.	Slight	Deep to water	Favorable	Erodes easily	Erodes easily.
Gc: Geary	Moderate: seepage, slope.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.
Hb: Harney	Moderate: seepage.	Moderate: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
He*:						
Harney	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Wakeen	Moderate: seepage, depth to rock, slope.	Moderate: thin layer, piping.	Deep to water	Depth to rock, slope.	Depth to rock, erodes easily.	Erodes easily, depth to rock.
Hm*:						
Harney	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Wells	Moderate: seepage, slope.	Moderate: thin layer, piping.	Deep to water	Slope	Favorable	Favorable.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Ho, Hr------------ Hord	Moderate: seepage.	Moderate: piping.	Deep to water	Favorable------	Favorable------	Favorable.
Jc---------------- Jansen	Severe: seepage.	Severe: seepage, piping.	Deep to water	Rooting depth	Too sandy------	Rooting depth.
Lh*:						
Lancaster--------	Moderate: seepage, depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
Hedville---------	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Slope, depth to rock.	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.
Mb---------------- McCook	Moderate: seepage.	Severe: piping.	Deep to water	Flooding-------	Erodes easily	Erodes easily.
Mc---------------- McCook	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
Mf---------------- McCook	Moderate: seepage.	Severe: piping.	Deep to water	Flooding-------	Erodes easily	Erodes easily.
Mn---------------- Meadin	Severe: seepage, slope.	Severe: seepage.	Deep to water	Slope, droughty.	Slope, too sandy, soil blowing.	Slope, droughty.
Nw*:						
Nibson-----------	Severe: depth to rock, slope.	Severe: thin layer.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
Wakeen-----------	Severe: slope.	Moderate: thin layer, piping.	Deep to water	Depth to rock, slope.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
Rb---------------- Roxbury	Moderate: seepage.	Moderate: thin layer, piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
Rf---------------- Roxbury	Moderate: seepage.	Moderate: thin layer, piping.	Deep to water	Flooding-------	Erodes easily	Erodes easily.
To---------------- Tobin	Moderate: seepage.	Moderate: piping.	Deep to water	Flooding-------	Favorable------	Favorable.
Wr---------------- Wells	Moderate: seepage.	Moderate: thin layer, piping.	Deep to water	Favorable------	Favorable------	Favorable.
Ws---------------- Wells	Moderate: seepage, slope.	Moderate: thin layer, piping.	Deep to water	Slope----------	Favorable------	Favorable.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Ar, Au: Armo	0-15	Loam	CL	A-6, A-4	0	95-100	90-100	90-100	70-95	25-40	7-18
	15-30	Loam, silty clay loam, clay loam.	CL	A-6, A-4, A-7	0	95-100	90-100	90-100	70-90	25-45	7-22
	30-60	Clay loam, loam, gravelly clay loam.	CL, SC, GC	A-6, A-4, A-7	0	60-85	50-85	50-60	40-55	25-35	8-18
Cb: Cass	0-13	Fine sandy loam	SM, SM-SC	A-4, A-2	0	100	95-100	85-95	20-40	<20	NP-5
	13-45	Fine sandy loam, sandy loam.	SM, SM-SC	A-4, A-2	0	100	95-100	85-95	20-50	<20	NP-5
	45-60	Loamy fine sand, fine sandy loam.	SM, SP-SM	A-2, A-3	0	95-100	95-100	50-75	5-30	---	NP
Cd: Crete	0-7	Silt loam	CL, ML	A-4, A-6	0	100	100	100	95-100	30-40	5-15
	7-34	Silty clay, silty clay loam.	CH	A-7	0	100	100	100	95-100	50-65	25-40
	34-60	Silty clay loam, silt loam.	CL, CH	A-6, A-7	0	100	100	100	95-100	30-55	10-35
Ed: Edalgo	0-8	Loam	CL, CL-ML	A-4, A-6	0	95-100	85-100	75-100	50-90	20-40	5-15
	8-34	Clay, clay loam	CH, CL	A-7	0	95-100	85-100	75-100	70-95	45-70	20-40
	34	Weathered bedrock.	---	---	---	---	---	---	---	---	---
Eh*, Ev*:											
Edalgo	0-8	Loam	CL, CL-ML	A-4, A-6	0	95-100	85-100	75-100	50-90	20-40	5-15
	8-34	Clay, clay loam	CH, CL	A-7	0	95-100	85-100	75-100	70-95	45-70	20-40
	34	Weathered bedrock.	---	---	---	---	---	---	---	---	---
Hedville	0-16	Loam	SM, ML, SC, CL	A-4, A-6, A-2	0-15	70-100	70-100	50-85	25-60	<35	NP-13
	16	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Gb, Gc: Geary	0-13	Silt loam	CL, CL-ML	A-4, A-6	0	100	100	96-100	80-98	25-40	4-15
	13-48	Silty clay loam	CL	A-7, A-6	0	100	100	96-100	85-98	35-50	15-25
	48-60	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	100	96-100	85-98	30-45	11-22
Hb: Harney	0-14	Silt loam	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
	14-40	Silty clay, silty clay loam.	CL, CH	A-7-6	0	100	100	95-100	85-100	40-60	15-35
	40-60	Silty clay loam, silt loam.	CL	A-6, A-7-6	0	100	100	95-100	85-100	30-45	10-20
He*:											
Harney	0-6	Silty clay loam	CL	A-6, A-7-6	0	100	100	95-100	85-100	30-45	15-22
	6-36	Silty clay, silty clay loam.	CL, CH	A-7-6	0	100	100	95-100	85-100	40-60	15-35
	36-60	Silty clay loam, silt loam.	CL	A-6, A-7-6	0	100	100	95-100	85-100	30-45	10-20

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification Unified	Classification AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
He*:											
Wakeen	0-9	Silt loam	CL	A-4, A-6	0	100	100	95-100	75-95	25-40	7-20
	9-30	Silty clay loam, silt loam.	CL, ML	A-6, A-7-6	0	95-100	85-100	75-100	60-95	30-50	10-25
	30	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Hm*:											
Harney	0-5	Silty clay loam	CL	A-6, A-7-6	0	100	100	95-100	85-100	30-45	15-22
	5-40	Silty clay, silty clay loam.	CL, CH	A-7-6	0	100	100	95-100	85-100	40-60	15-35
	40-60	Silty clay loam, silt loam.	CL	A-6, A-7-6	0	100	100	95-100	85-100	30-45	10-20
Wells	0-11	Loam	CL-ML, CL	A-4, A-6	0	100	100	95-100	65-85	20-35	5-20
	11-44	Clay loam, sandy clay loam.	SC, CL	A-4, A-6, A-7	0	100	100	80-100	40-85	30-50	8-25
	44-60	Clay loam, sandy clay loam, sandy loam.	SC, CL, ML, SM	A-4, A-6	0	100	100	80-100	35-85	20-40	NP-15
Ho, Hr Hord	0-13	Silt loam	CL, ML, CL-ML	A-4, A-6	0	100	100	95-100	85-100	20-35	3-18
	13-60	Silt loam, silty clay loam, loam.	CL	A-6, A-4	0	100	100	98-100	85-100	25-40	8-23
Jc Jansen	0-13	Sandy loam	CL, ML	A-6, A-4	0	100	100	90-100	65-95	25-40	3-15
	13-28	Clay loam, sandy clay loam.	CL	A-6, A-7	0	95-100	90-100	80-100	50-80	30-45	10-25
	28-33	Loamy coarse sand	SM, SP-SM	A-2, A-4, A-1	0	95-100	90-100	45-85	10-45	---	NP
	33-60	Coarse sand, sand, gravelly coarse sand.	SW, SW-SM, SP, SP-SM	A-3, A-1, A-2	0	85-100	45-100	35-65	3-10	---	NP
Lh*:											
Lancaster	0-16	Loam	CL-ML, CL	A-4, A-6	0-5	95-100	90-100	85-100	60-90	20-35	5-15
	16-32	Sandy clay loam, clay loam.	CL, SC	A-4, A-6, A-7-6	0	100	95-100	80-95	40-65	25-45	8-25
	32	Weathered bedrock	---	---	---	---	---	---	---	---	---
Hedville	0-16	Loam	SM, ML, SC, CL	A-4, A-6, A-2	0-15	70-100	70-100	50-85	25-60	<35	NP-13
	16	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Mb McCook	0-12	Loam	ML, CL, CL-ML	A-4	0	100	100	95-100	60-100	20-35	2-10
	12-60	Very fine sandy loam, silt loam, loam.	ML, CL, CL-ML	A-4	0	100	100	95-100	80-100	<20	NP-10
Mc McCook	0-12	Silt loam	ML, CL, CL-ML	A-4	0	100	100	95-100	60-100	20-35	2-10
	12-60	Very fine sandy loam, silt loam, loam.	ML, CL, CL-ML	A-4	0	100	100	95-100	55-100	<20	NP-10

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Mf-------------- McCook	0-15	Silty clay loam	CL	A-6, A-7	0	100	100	90-100	70-95	25-45	11-20
	15-60	Very fine sandy loam, silt loam, loam.	ML, CL, CL-ML	A-4	0	100	100	95-100	80-100	<20	NP-10
Mn-------------- Meadin	0-14	Sandy loam-------	SM, ML, CL-ML, SM-SC	A-2, A-4	0	85-100	75-95	45-80	25-55	<20	NP-5
	14-60	Gravelly coarse sand, very gravelly coarse sand, gravelly sand.	SP-SM, SP, GP-GM, GP	A-1	0	40-80	30-70	15-50	1-10	---	NP
Nw*:											
Nibson----------	0-8	Silt loam--------	CL	A-4, A-6	0-15	85-100	80-95	65-95	60-90	25-40	8-20
	8-19	Silty clay loam, silt loam.	CL	A-6, A-7	0-15	85-95	80-95	60-90	55-90	30-45	10-25
	19	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Wakeen----------	0-9	Silt loam--------	CL	A-4, A-6	0	100	100	95-100	75-95	25-40	7-20
	9-30	Silty clay loam, silt loam.	CL, ML	A-6, A-7-6	0	95-100	85-100	75-100	60-95	30-50	10-25
	30	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Rb, Rf---------- Roxbury	0-20	Silt loam--------	CL	A-4, A-6	0	100	100	95-100	65-100	25-40	7-20
	20-60	Silt loam, silty clay loam, loam.	ML, CL	A-4, A-6, A-7-6	0	100	100	95-100	65-100	30-50	7-25
To-------------- Tobin	0-20	Silt loam--------	CL	A-4, A-6	0	100	100	95-100	90-100	25-35	8-15
	20-60	Silt loam, silty clay loam, loam.	CL	A-4, A-6, A-7	0	100	100	95-100	90-100	25-45	8-20
Wr, Ws---------- Wells	0-11	Loam------------	CL-ML, CL	A-4, A-6	0	100	100	95-100	65-85	20-35	5-20
	11-44	Clay loam, sandy clay loam.	SC, CL	A-4, A-6, A-7	0	100	100	80-100	40-85	30-50	8-25
	44-60	Clay loam, sandy clay loam, sandy loam.	SC, CL, ML, SM	A-4, A-6	0	100	100	80-100	35-85	20-40	NP-15

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
Ar, Au-----------	0-15	18-27	1.25-1.40	0.6-2.0	0.21-0.24	6.6-8.4	<2	Low--------	0.28	5	4L	1-3
Armo	15-30	18-35	1.30-1.40	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.28			
	30-60	18-35	1.30-1.45	0.6-2.0	0.15-0.21	7.9-8.4	<2	Low--------	0.28			
Cb---------------	0-13	7-17	1.40-1.60	2.0-6.0	0.16-0.18	5.6-7.3	<2	Low--------	0.20	5	3	1-2
Cass	13-45	5-15	1.40-1.60	2.0-6.0	0.15-0.17	6.1-8.4	<2	Low--------	0.20			
	45-60	2-10	1.50-1.70	6.0-20	0.08-0.10	6.1-8.4	<2	Low--------	0.20			
Cd---------------	0-7	20-27	1.20-1.40	0.6-2.0	0.22-0.24	5.6-6.5	<2	Moderate	0.37	4	6	2-4
Crete	7-34	42-52	1.10-1.30	0.06-0.6	0.12-0.20	6.1-7.3	<2	High-------	0.37			
	34-60	25-40	1.20-1.40	0.2-2.0	0.18-0.22	7.4-8.4	<2	High-------	0.37			
Ed---------------	0-8	15-27	1.30-1.40	0.6-2.0	0.18-0.24	5.6-7.3	<2	Low--------	0.37	3	6	2-4
Edalgo	8-34	35-65	1.40-1.60	<0.06	0.10-0.18	6.6-8.4	<2	High-------	0.37			
	34	---	---	---	---	---	---	-----------	----			
Eh*, Ev*:												
Edalgo-----------	0-8	15-27	1.30-1.40	0.6-2.0	0.18-0.24	5.6-7.3	<2	Low--------	0.37	3	6	2-4
	8-34	35-65	1.40-1.60	<0.06	0.10-0.18	6.6-8.4	<2	High-------	0.37			
	34	---	---	---	---	---	---	-----------	----			
Hedville---------	0-16	8-22	1.35-1.50	0.6-2.0	0.09-0.14	5.6-7.3	<2	Low--------	0.24	2	6	1-4
	16	---	---	---	---	---	---	-----------	----			
Gb, Gc-----------	0-13	15-27	1.30-1.40	0.6-2.0	0.22-0.24	5.6-6.5	<2	Low--------	0.32	5	6	1-4
Geary	13-48	27-35	1.35-1.50	0.6-2.0	0.17-0.20	5.6-7.8	<2	Moderate	0.43			
	48-60	20-32	1.30-1.40	0.6-2.0	0.15-0.19	6.1-8.4	<2	Moderate	0.43			
Hb---------------	0-14	22-27	1.30-1.40	0.6-2.0	0.22-0.24	5.6-7.8	<2	Low--------	0.32	5	6	2-4
Harney	14-40	35-42	1.35-1.50	0.2-0.6	0.12-0.19	6.1-8.4	<2	Moderate	0.43			
	40-60	24-35	1.20-1.35	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.43			
He*:												
Harney-----------	0-6	28-35	1.30-1.40	0.6-2.0	0.21-0.23	5.6-7.8	<2	Moderate	0.32	5	7	2-4
	6-36	35-42	1.35-1.50	0.2-0.6	0.12-0.19	6.1-8.4	<2	Moderate	0.43			
	36-60	24-35	1.20-1.35	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.43			
Wakeen-----------	0-9	18-27	1.30-1.45	0.6-2.0	0.22-0.24	7.4-8.4	<2	Low--------	0.32	4	4L	1-3
	9-30	18-35	1.35-1.50	0.6-2.0	0.18-0.22	7.4-9.0	<2	Moderate	0.43			
	30	---	---	---	---	---	---	-----------	----			
Hm*:												
Harney-----------	0-5	28-35	1.30-1.40	0.6-2.0	0.21-0.23	5.6-7.8	<2	Moderate	0.32	5	7	2-4
	5-40	35-42	1.35-1.50	0.2-0.6	0.12-0.19	6.1-8.4	<2	Moderate	0.43			
	40-60	24-35	1.20-1.35	0.6-2.0	0.18-0.22	7.4-8.4	<2	Low--------	0.43			
Wells------------	0-11	18-27	1.35-1.50	0.6-2.0	0.20-0.22	5.6-6.5	<2	Low--------	0.28	5	6	1-4
	11-44	25-35	1.35-1.50	0.6-2.0	0.15-0.19	5.6-7.3	<2	Moderate	0.28			
	44-60	10-30	1.35-1.60	0.6-2.0	0.12-0.18	6.1-7.8	<2	Low--------	0.28			
Ho, Hr-----------	0-13	17-27	1.30-1.40	0.6-2.0	0.20-0.24	5.6-7.3	<2	Low--------	0.32	5	6	2-4
Hord	13-60	20-35	1.35-1.45	0.6-2.0	0.17-0.22	6.1-7.8	<2	Low--------	0.32			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
Jc----------------Jansen	0-13	12-22	1.20-1.30	0.6-2.0	0.20-0.24	5.1-7.3	<2	Low--------	0.20	4	6	1-3
	13-28	18-32	1.10-1.25	0.6-2.0	0.15-0.19	5.1-7.3	<2	Moderate	0.32			
	28-33	2-7	1.45-1.65	6.0-20	0.06-0.11	5.1-7.3	<2	Low--------	0.10			
	33-60	0-3	1.50-1.70	>20	0.02-0.04	5.1-7.3	<2	Low--------	0.10			
Lh*:												
Lancaster--------	0-16	12-26	1.35-1.45	0.6-2.0	0.17-0.22	5.6-6.5	<2	Low--------	0.28	4	6	1-4
	16-32	18-35	1.35-1.50	0.6-2.0	0.15-0.19	5.6-7.3	<2	Moderate	0.28			
	32	---	---	---	---	---	---	----------	----			
Hedville---------	0-16	8-22	1.35-1.50	0.6-2.0	0.09-0.14	5.6-7.3	<2	Low--------	0.24	2	6	1-4
	16	---	---	---	---	---	---	----------	----			
Mb, Mc-----------McCook	0-12	15-20	1.20-1.40	0.6-2.0	0.20-0.24	7.4-8.4	<2	Low--------	0.32	5	4L	2-4
	12-60	10-18	1.30-1.45	0.6-2.0	0.17-0.20	7.4-8.4	<2	Low--------	0.43			
Mf----------------McCook	0-15	27-35	1.20-1.40	0.2-0.6	0.17-0.23	7.4-8.4	<2	Moderate	0.32	5	4L	2-4
	15-60	10-18	1.30-1.45	0.6-2.0	0.17-0.20	7.4-8.4	<2	Low--------	0.43			
Mn----------------Meadin	0-14	5-12	1.50-1.60	0.6-2.0	0.13-0.18	5.1-7.3	<2	Low--------	0.20	3	3	1-2
	14-60	2-5	1.50-1.70	>20	0.02-0.05	6.1-7.3	<2	Low--------	0.10			
Nw*:												
Nibson-----------	0-8	15-27	1.25-1.35	0.6-2.0	0.20-0.24	7.4-9.0	<2	Low--------	0.32	2	4L	---
	8-19	18-35	1.30-1.40	0.6-2.0	0.18-0.22	7.9-9.0	<2	Moderate	0.32			
	19	---	---	---	---	---	---	----------	----			
Wakeen-----------	0-9	18-27	1.30-1.45	0.6-2.0	0.22-0.24	7.4-8.4	<2	Low--------	0.32	4	4L	1-3
	9-30	18-35	1.35-1.50	0.6-2.0	0.18-0.22	7.4-9.0	<2	Moderate	0.43			
	30	---	---	---	---	---	---	----------	----			
Rb----------------Roxbury	0-20	18-27	1.30-1.45	0.6-2.0	0.22-0.24	7.4-8.4	<2	Low--------	0.32	5	4L	2-4
	20-60	18-35	1.35-1.50	0.6-2.0	0.17-0.22	7.4-8.4	<2	Moderate	0.43			
Rf----------------Roxbury	0-20	18-27	1.30-1.45	0.6-2.0	0.22-0.24	6.6-8.4	<2	Low--------	0.32	5	4L	2-4
	20-60	18-35	1.35-1.50	0.6-2.0	0.17-0.22	7.4-8.4	<2	Moderate	0.43			
To----------------Tobin	0-20	18-27	1.30-1.40	0.6-2.0	0.20-0.24	5.6-7.8	<2	Moderate	0.32	5	6	1-4
	20-60	18-35	1.35-1.50	0.6-2.0	0.17-0.20	7.4-8.4	<2	Moderate	0.32			
Wr, Ws-----------Wells	0-11	18-27	1.35-1.50	0.6-2.0	0.20-0.22	5.6-6.5	<2	Low--------	0.28	5	6	1-4
	11-44	25-35	1.35-1.50	0.6-2.0	0.15-0.19	5.6-7.3	<2	Moderate	0.28			
	44-60	10-30	1.35-1.60	0.6-2.0	0.12-0.18	6.1-7.8	<2	Low--------	0.28			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

("Flooding" and terms such as "rare" and "brief" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydro- logic group	Flooding			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Hardness		Uncoated steel	Concrete
					In				
Ar, Au------------ Armo	B	None--------	---	---	>60	---	Low------	Low------	Low.
Cb---------------- Cass	B	Occasional	Brief-----	Mar-Jun	>60	---	Moderate	Moderate	Low.
Cd---------------- Crete	C	None--------	---	---	>60	---	Moderate	Moderate	Low.
Ed---------------- Edalgo	C	None--------	---	---	20-40	Soft	Moderate	Moderate	Low.
Eh*, Ev*:									
Edalgo-----------	C	None--------	---	---	20-40	Soft	Moderate	Moderate	Low.
Hedville---------	D	None--------	---	---	4-20	Hard	Moderate	Low------	Moderate.
Gb, Gc------------ Geary	B	None--------	---	---	>60	---	High-----	Low------	Low.
Hb---------------- Harney	B	None--------	---	---	>60	---	Low------	High-----	Low.
He*:									
Harney-----------	B	None--------	---	---	>60	---	Low------	High-----	Low.
Wakeen-----------	B	None--------	---	---	20-40	Soft	Low------	Moderate	Low.
Hm*:									
Harney-----------	B	None--------	---	---	>60	---	Low------	High-----	Low.
Wells------------	B	None--------	---	---	>60	---	Moderate	Low------	Moderate.
Ho---------------- Hord	B	None--------	---	---	>60	---	Moderate	High-----	Low.
Hr---------------- Hord	B	Rare--------	---	---	>60	---	Moderate	High-----	Low.
Jc---------------- Jansen	B	None--------	---	---	>60	---	Moderate	Moderate	Low.
Lh*:									
Lancaster--------	B	None--------	---	---	20-40	Soft	Moderate	Low------	Moderate.
Hedville---------	D	None--------	---	---	4-20	Hard	Moderate	Low------	Moderate.
Mb---------------- McCook	B	Occasional	Very brief	Apr-Jul	>60	---	Moderate	Low------	Low.
Mc---------------- McCook	B	Rare--------	---	---	>60	---	Moderate	Low------	Low.
Mf---------------- McCook	B	Frequent----	Very brief	Apr-Jul	>60	---	Moderate	Low------	Low.
Mn---------------- Meadin	A	None--------	---	---	>60	---	Low------	Low------	Moderate.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Hardness		Uncoated steel	Concrete
					In				
Nw*:									
Nibson	D	None	---	---	10-20	Soft	Moderate	Low	Low.
Wakeen	B	None	---	---	20-40	Soft	Low	Moderate	Low.
Rb Roxbury	B	Rare	---	---	>60	---	Moderate	Low	Low.
Rf Roxbury	B	Occasional	Very brief	Apr-Sep	>60	---	Moderate	Low	Low.
To Tobin	B	Occasional	Very brief	Mar-Dec	>60	---	Moderate	Low	Low.
Wr, Ws Wells	B	None	---	---	>60	---	Moderate	Low	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--ENGINEERING INDEX TEST DATA

(LL means liquid limit; PI, plasticity index; MD, maximum dry density; and OM, optimum moisture)

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution							LL	PI	Moisture density	
			Percentage passing sieve--				Percentage smaller than--					MD	OM
	AASHTO	Unified	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm				
										Pct		Lb/ft3	Pct
Armo loam:													
(S81KS-053-004)													
A1----- 0 to 9	A-7	ML	100	98	86	71	41	16	9	41	15	100	19
Bw----- 15 to 30	A-7	ML	100	100	84	70	48	24	15	45	17	96	24
C------ 30 to 60	A-6	CL	100	100	88	72	56	42	29	38	14	103	18
Edalgo loam:													
(S81KS-053-003)													
Ap----- 0 to 8	A-4	CL-ML, CL	100	100	99	91	46	21	15	29	7	106	16
Bt2---- 14 to 23	A-7	CL	100	100	92	74	53	35	27	45	22	101	20
C------ 23 to 34	A-6	CL	100	100	92	72	48	37	31	35	18	116	15
Cr----- 34 to 60	A-6	CL	100	100	82	70	58	46	39	39	20	115	14
Nibson silt loam:													
(S81KS-053-001)													
A------ 0 to 8	A-7	CL-ML	100	100	93	87	45	16	6	43	17	93	22
Bw----- 8 to 14	A-6	CL-ML	100	98	92	77	42	21	13	39	14	99	19
C------ 14 to 19	A-7	ML	100	100	84	62	36	25	16	41	14	99	19
Cr----- 19 to 44	A-7	CL	100	100	88	69	53	38	27	45	25	106	16
Wells loam:													
(S81KS-053-002)													
Ap----- 0 to 11	A-4	CL	100	100	97	64	38	22	19	29	10	108	15
Bt1---- 11 to 22	A-6	CL	100	100	99	72	47	27	17	33	14	106	17
C------ 44 to 60	A-4	CL	100	100	96	56	36	20	15	23	8	118	13

TABLE 18.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Armo	Fine-loamy, mixed, mesic Entic Haplustolls
Cass	Coarse-loamy, mixed, mesic Fluventic Haplustolls
Crete	Fine, montmorillonitic, mesic Pachic Argiustolls
Edalgo	Fine, mixed, mesic Udic Argiustolls
Geary	Fine-silty, mixed, mesic Udic Argiustolls
Harney	Fine, montmorillonitic, mesic Typic Argiustolls
Hedville	Loamy, mixed, mesic Lithic Haplustolls
Hord	Fine-silty, mixed, mesic Cumulic Haplustolls
Jansen	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Argiustolls
Lancaster	Fine-loamy, mixed, mesic Udic Argiustolls
McCook	Coarse-silty, mixed, mesic Fluventic Haplustolls
Meadin	Sandy, mixed, mesic Entic Haplustolls
Nibson	Loamy, carbonatic, mesic, shallow Entic Haplustolls
Roxbury	Fine-silty, mixed, mesic Cumulic Haplustolls
Tobin	Fine-silty, mixed, mesic Cumulic Haplustolls
Wakeen	Fine-silty, carbonatic, mesic Entic Haplustolls
Wells	Fine-loamy, mixed, mesic Udic Argiustolls

Interpretive Groups

INTERPRETIVE GROUPS

(Dashes indicate that the soil was not assigned to the interpretive group)

Map symbol	Map unit	Land capability*	Prime farmland*	Range site
Ar	Armo loam, 3 to 7 percent slopes	IIIe	Yes	Limy Upland.
Au	Armo loam, 7 to 15 percent slopes	VIe	No	Limy Upland.
Cb	Cass fine sandy loam	IIw	Yes	Sandy Lowland.
Cd	Crete silt loam, 0 to 2 percent slopes	IIs	Yes	Clay Upland.
Ed	Edalgo loam, 3 to 7 percent slopes	IVe	No	Clay Upland.
Eh	Edalgo-Hedville loams, 7 to 15 percent slopes	VIe	No	
	Edalgo			Clay Upland.
	Hedville			Shallow Sandstone.
Ev	Edalgo-Hedville loams, 15 to 40 percent slopes	VIIe	No	
	Edalgo			Clay Upland.
	Hedville			Shallow Sandstone.
Gb	Geary silt loam, 1 to 3 percent slopes	IIe	Yes	Loamy Upland.
Gc	Geary silt loam, 3 to 7 percent slopes	IIIe	Yes	Loamy Upland.
Hb	Harney silt loam, 1 to 3 percent slopes	IIe	Yes	Loamy Upland.
He	Harney-Wakeen complex, 2 to 6 percent slopes	IVe	Yes	
	Harney			Loamy Upland.
	Wakeen			Limy Upland.
Hm	Harney-Wells complex, 2 to 6 percent slopes	IIIe	Yes	
	Harney			Loamy Upland.
	Wells			Loamy Upland.
Ho	Hord silt loam, nonflooded	I	Yes	Loamy Terrace.
Hr	Hord silt loam, rarely flooded	I	Yes	Loamy Terrace.
Jc	Jansen sandy loam, 1 to 4 percent slopes	IIIe	Yes	Sandy.
Lh	Lancaster-Hedville loams, 3 to 20 percent slopes	VIe	No	
	Lancaster			Loamy Upland.
	Hedville			Shallow Sandstone.
Mb	McCook loam, occasionally flooded	IIw	Yes	Loamy Lowland.
Mc	McCook silt loam	I	Yes	Loamy Terrace.
Mf	McCook silty clay loam, frequently flooded	Vw	No	---
Mn	Meadin sandy loam, 3 to 15 percent slopes	VIs	No	Sandy.
Nw	Nibson-Wakeen silt loams, 5 to 25 percent slopes	VIe	No	
	Nibson			Limy Upland.
	Wakeen			Limy Upland.
Rb	Roxbury silt loam	I	Yes	Loamy Terrace.
Rf	Roxbury silt loam, occasionally flooded	IIw	Yes	Loamy Lowland.
To	Tobin silt loam, occasionally flooded	IIw	Yes	Loamy Lowland.
Wr	Wells loam, 1 to 3 percent slopes	IIe	Yes	Loamy Upland.
Ws	Wells loam, 3 to 7 percent slopes	IIIe	Yes	Loamy Upland.

* A soil complex is treated as a single management unit in the land capability and prime farmland columns.

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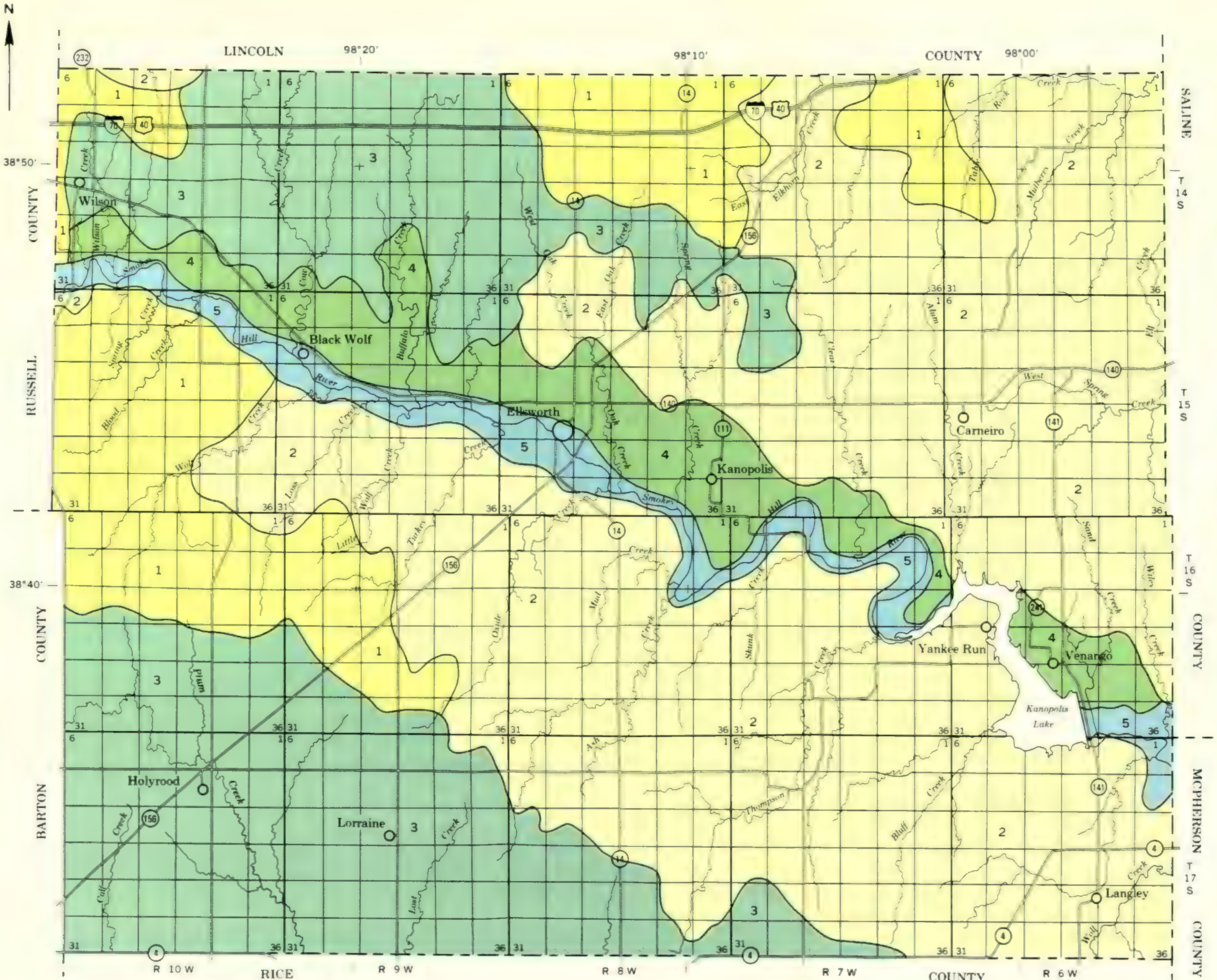


LEGEND

1 — HARNEY-ARMO association: Deep, gently sloping to strongly sloping, well drained soils that have a loamy, silty, or clayey subsoil; on uplands

2 — LANCASTER-HEDVILLE-HARNEY association: Deep to shallow, gently sloping to steep, well drained and somewhat excessively drained soils that have a loamy, silty, or clayey subsoil; on uplands

3 — CRETE-HARNEY association: Deep, nearly level to moderately sloping, moderately well drained and well drained soils that have a silty or clayey subsoil; on uplands

4 — WELLS-MEADIN association: Deep, gently sloping to strongly sloping, well drained and excessively drained soils that have a loamy subsoil; on uplands

5 — McCOOK-ROXBURY association: Deep, nearly level, well drained soils that have a loamy or silty subsoil; on stream terraces and flood plains

COMPILED 1986

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

U.S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
KANSAS AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

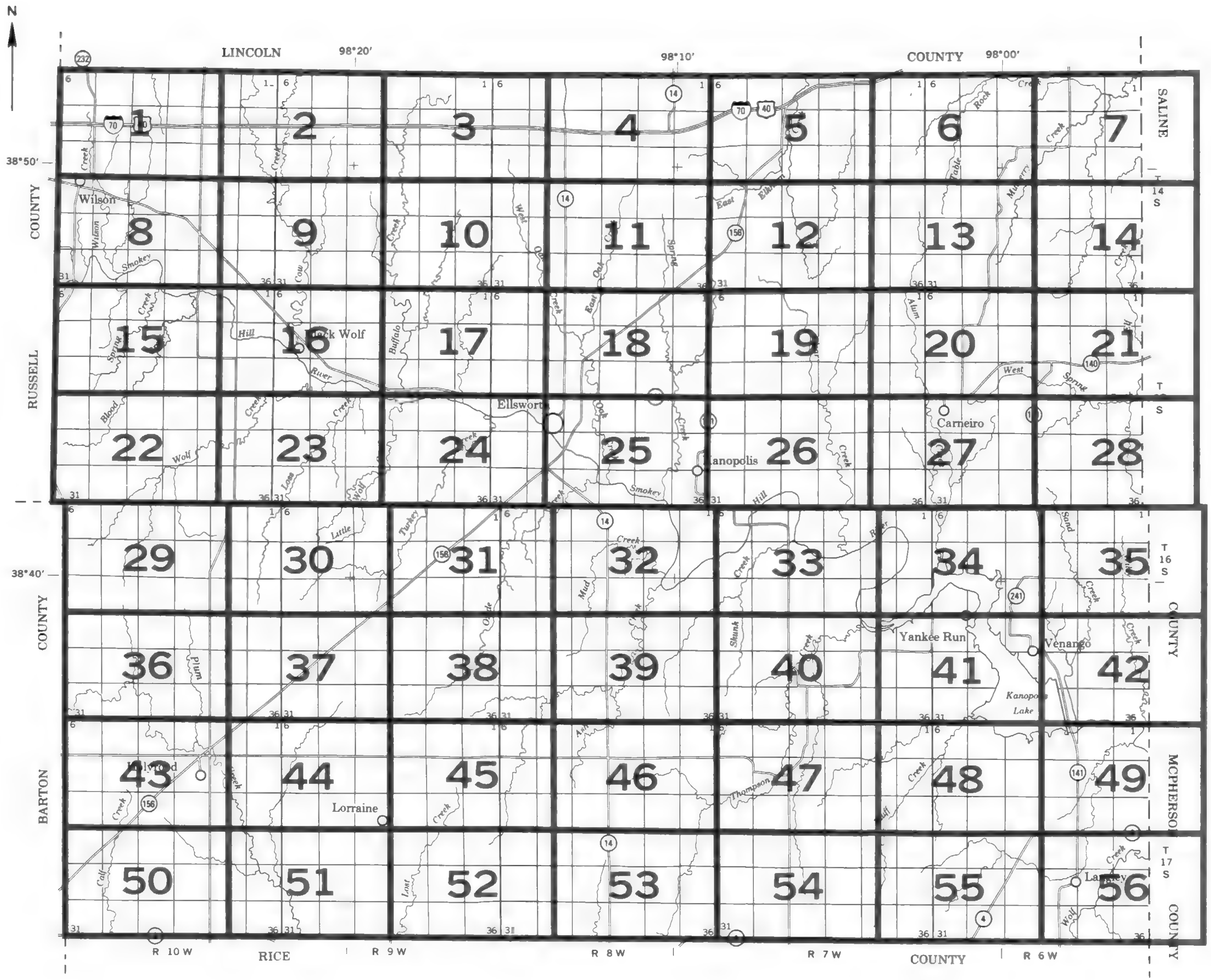
ELLSWORTH COUNTY, KANSAS

Scale 1:190,080

1 0 1 2 3 Miles

1 0 3 6 Km

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.



Original text from each individual map sheet read:
This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
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18	17	16	15	14	13
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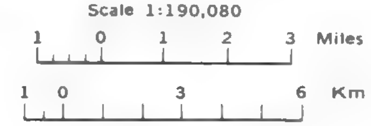
31	32	33	34	35	36

INDEX TO MAP SHEETS

ELLSWORTH COUNTY, KANSAS

Scale 1:190,080



SOIL LEGEND

SYMBOL	NAME
Ar	Armo loam, 3 to 7 percent slopes
Au	Armo loam, 7 to 15 percent slopes
Cb	Cass fine sandy loam
Cd	Crete silt loam, 0 to 2 percent slopes
Ed	Edalgo loam, 3 to 7 percent slopes
Eh	Edalgo-Hedville loams, 7 to 15 percent slopes
Ev	Edalgo-Hedville loams, 15 to 40 percent slopes
Gb	Geary silt loam, 1 to 3 percent slopes
Gc	Geary silt loam, 3 to 7 percent slopes
Hb	Harney silt loam, 1 to 3 percent slopes
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Rb	Roxbury silt loam
Rf	Roxbury silt loam, occasionally flooded
To	Tobin silt loam, occasionally flooded
Wr	Wells loam, 1 to 3 percent slopes
Ws	Wells loam, 3 to 7 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline and neatline

AD HOC BOUNDARY (label) — Swift Airport

Small airport, airfield, park, oilfield, cemetery, or flood pool — FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNER (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEM & DESIGNATIONS

- Interstate — 21
- Federal — 173
- State — 28
- County, farm or ranch — 1283

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or Small — water, w

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — Gas
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water, w
- Intermittent — int, i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — Au Rb

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

SOIL SAMPLE (normally not shown)

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Limy spot

SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 1

1

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SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 2

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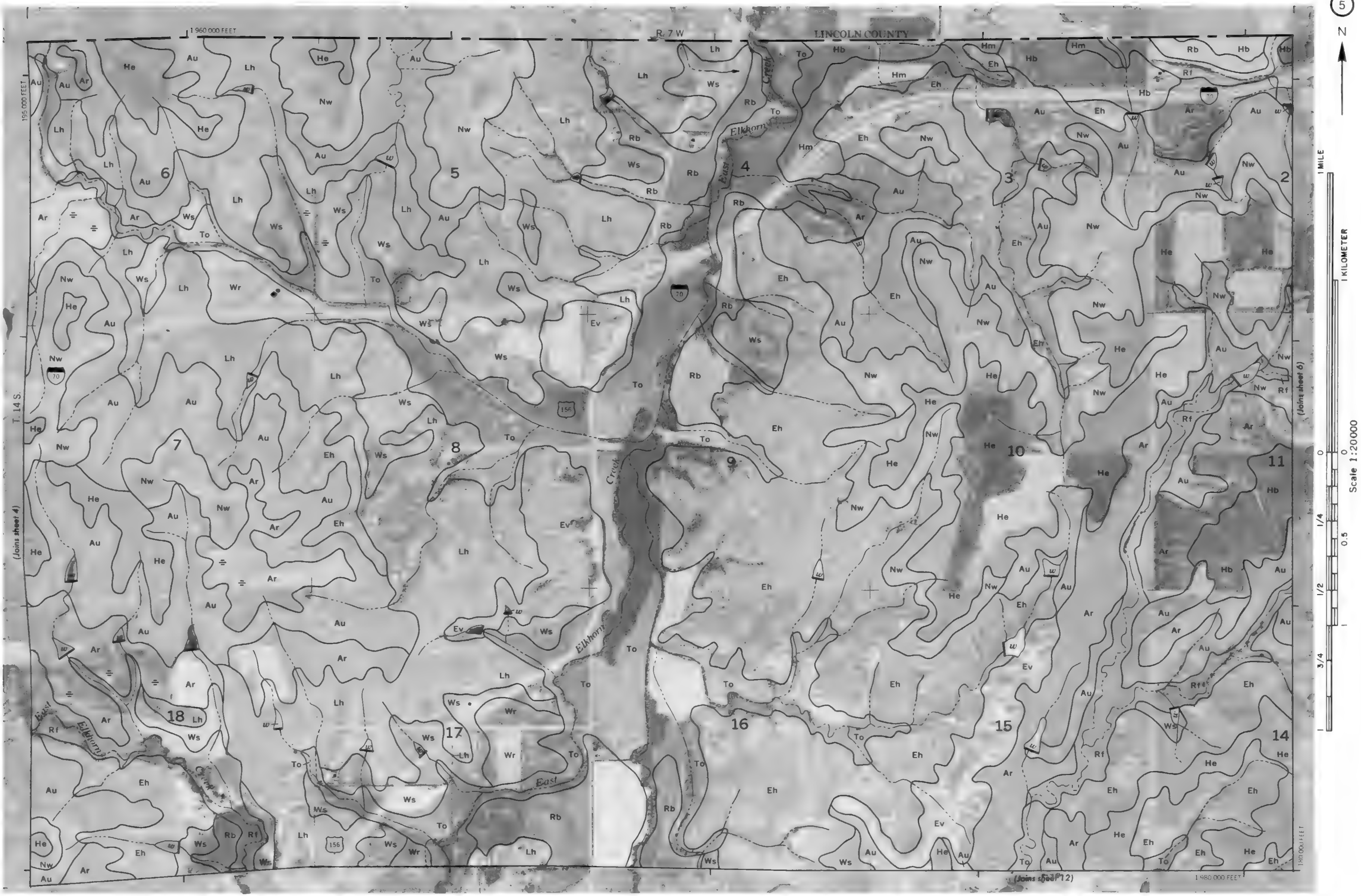
SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 5



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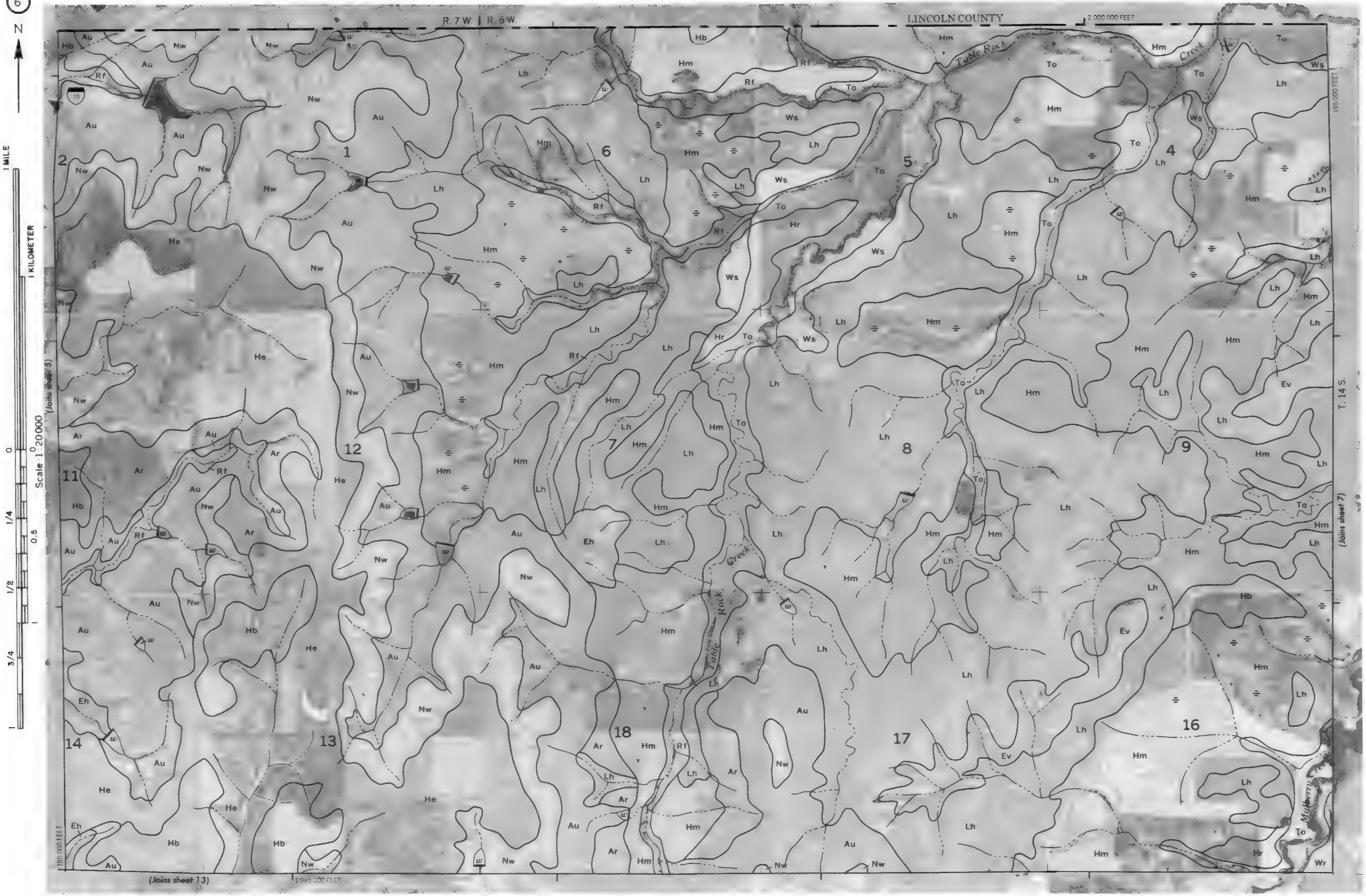

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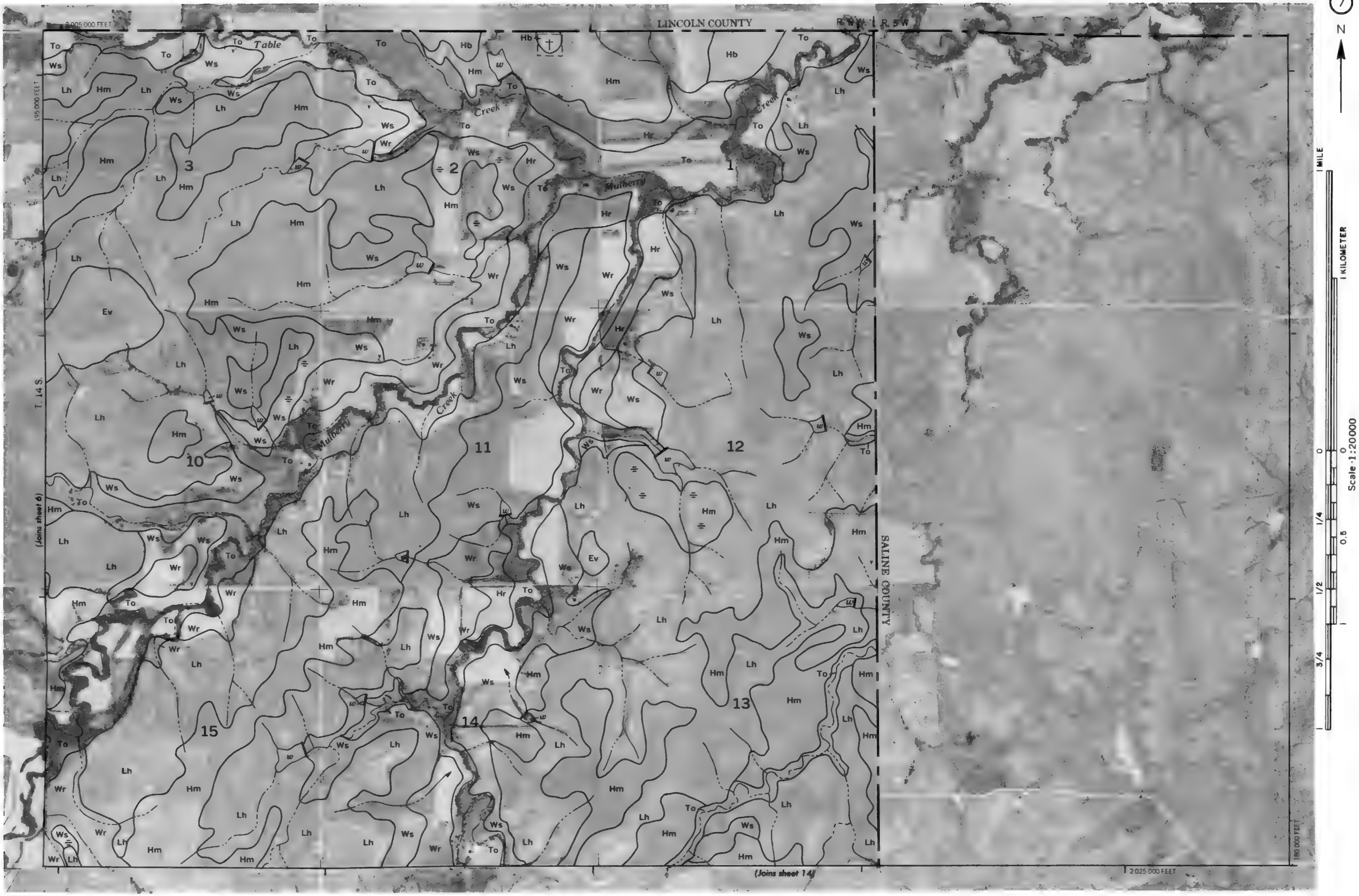

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SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 10

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SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 11

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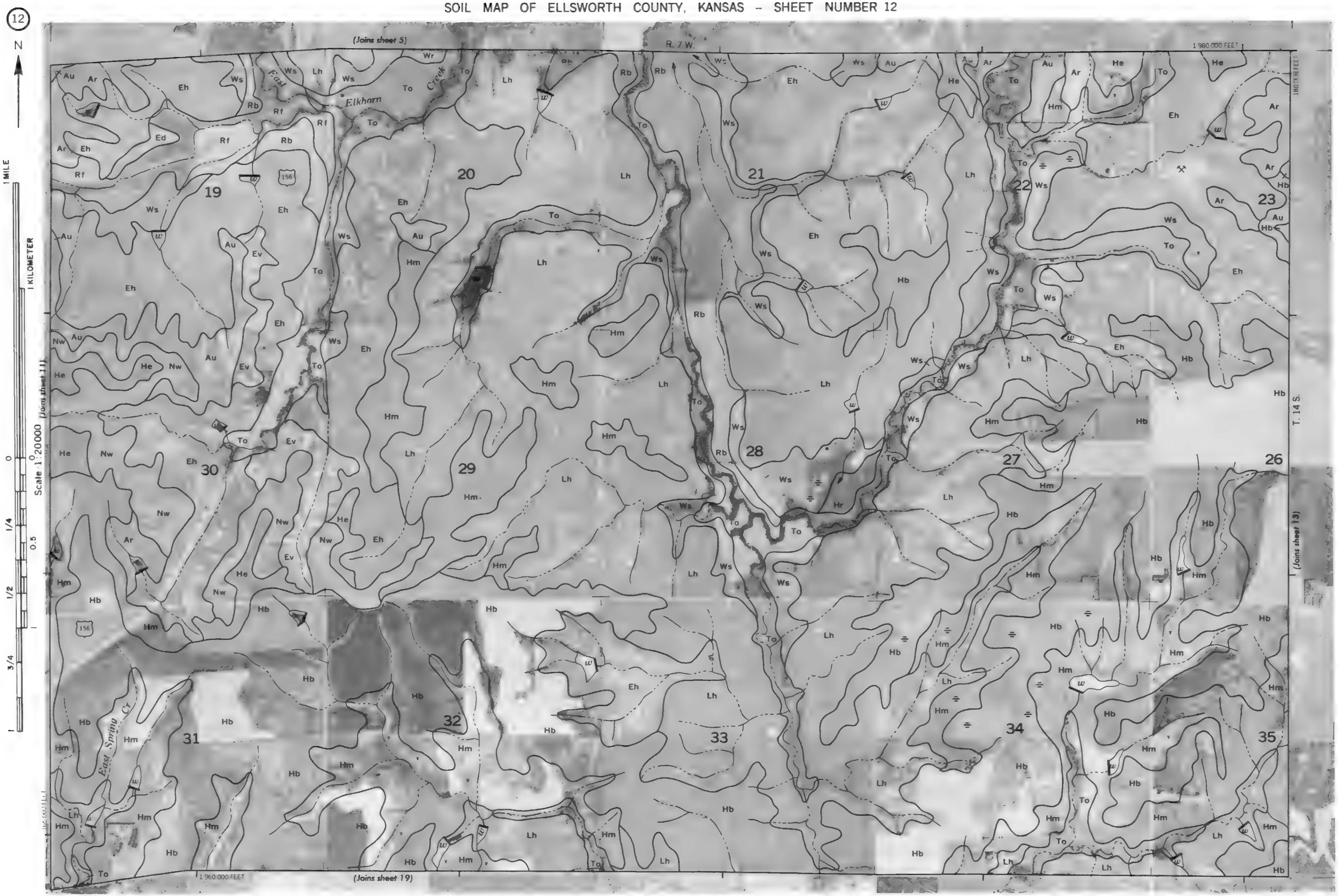
SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 12



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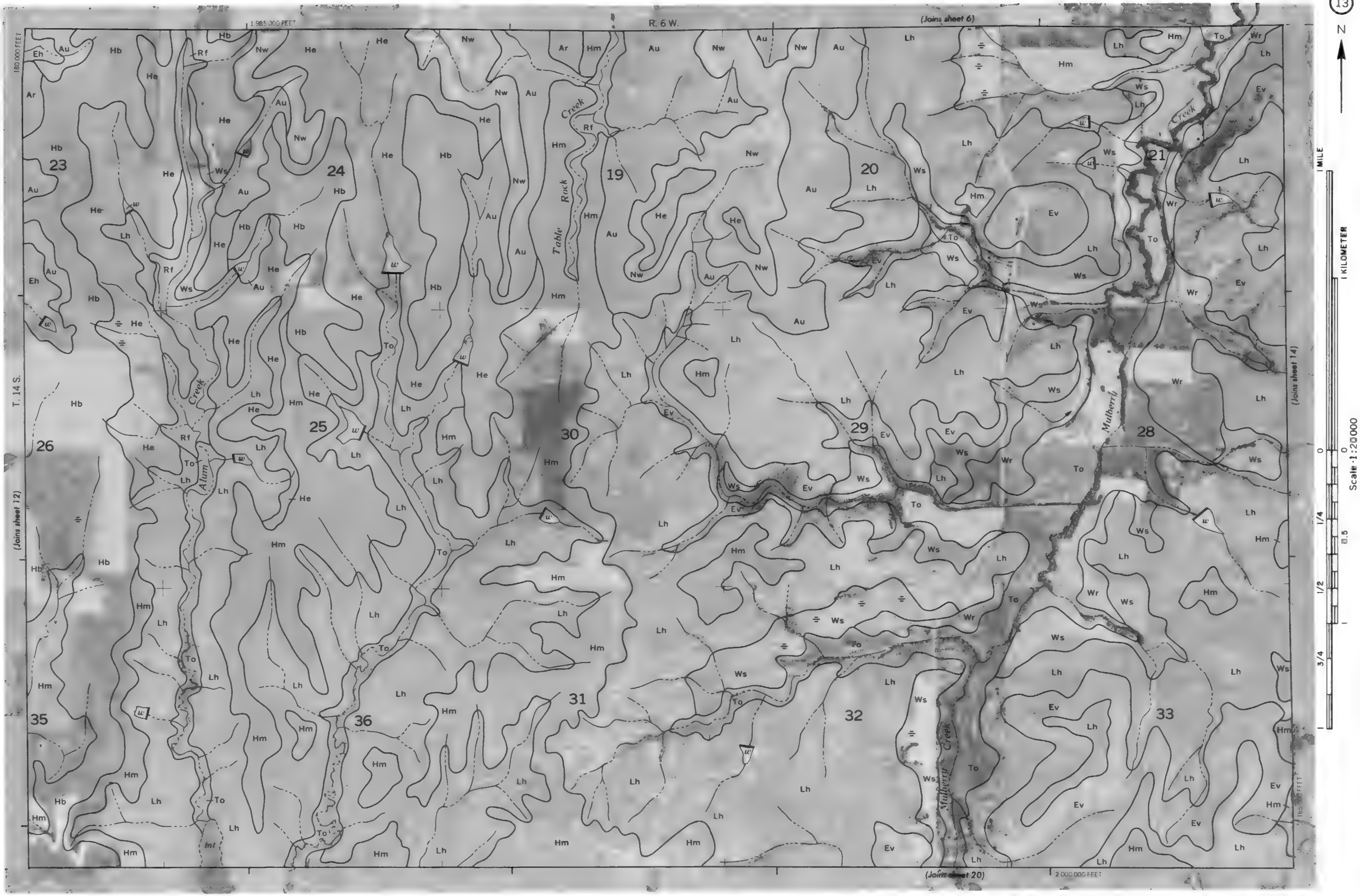

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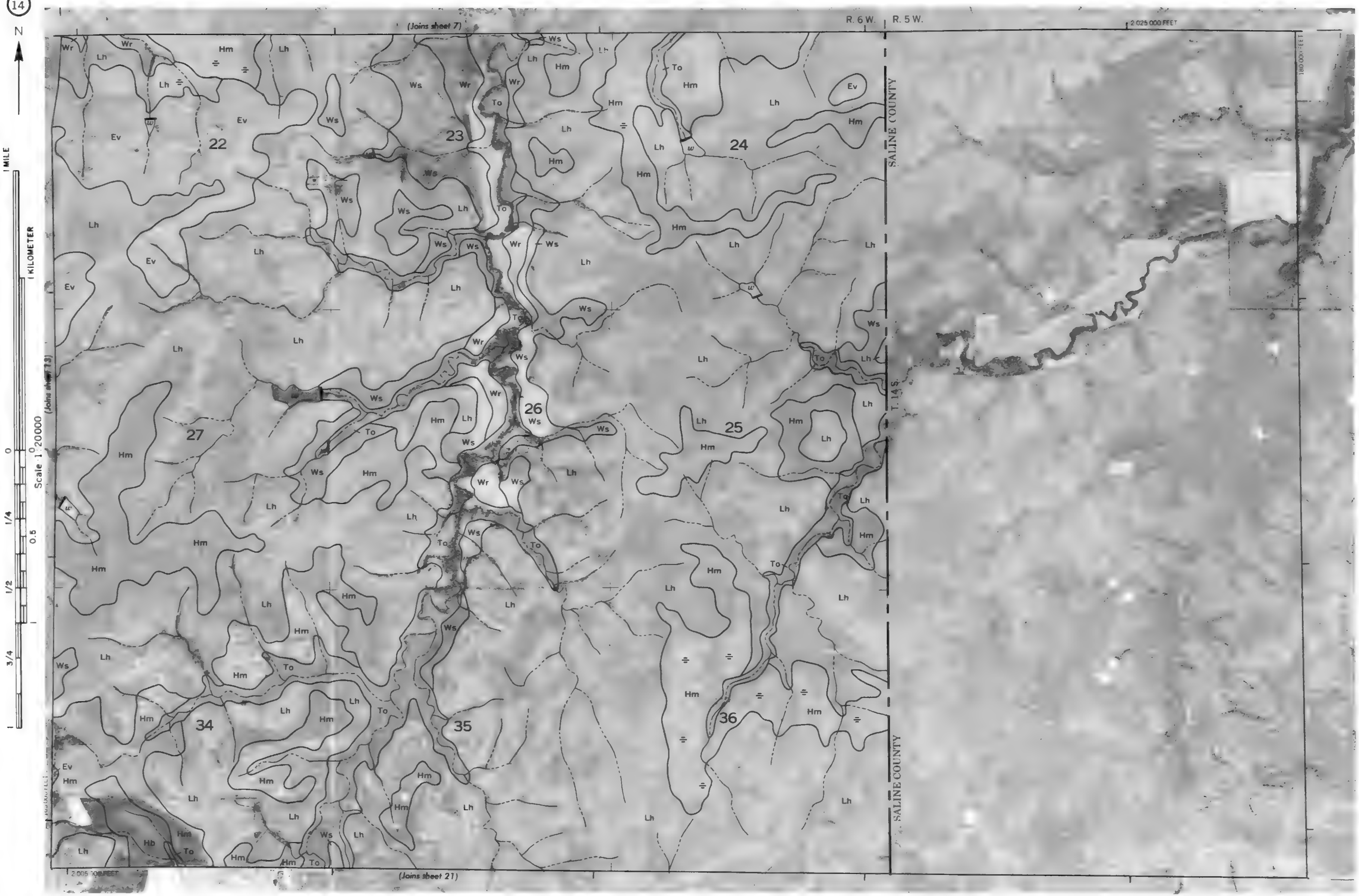

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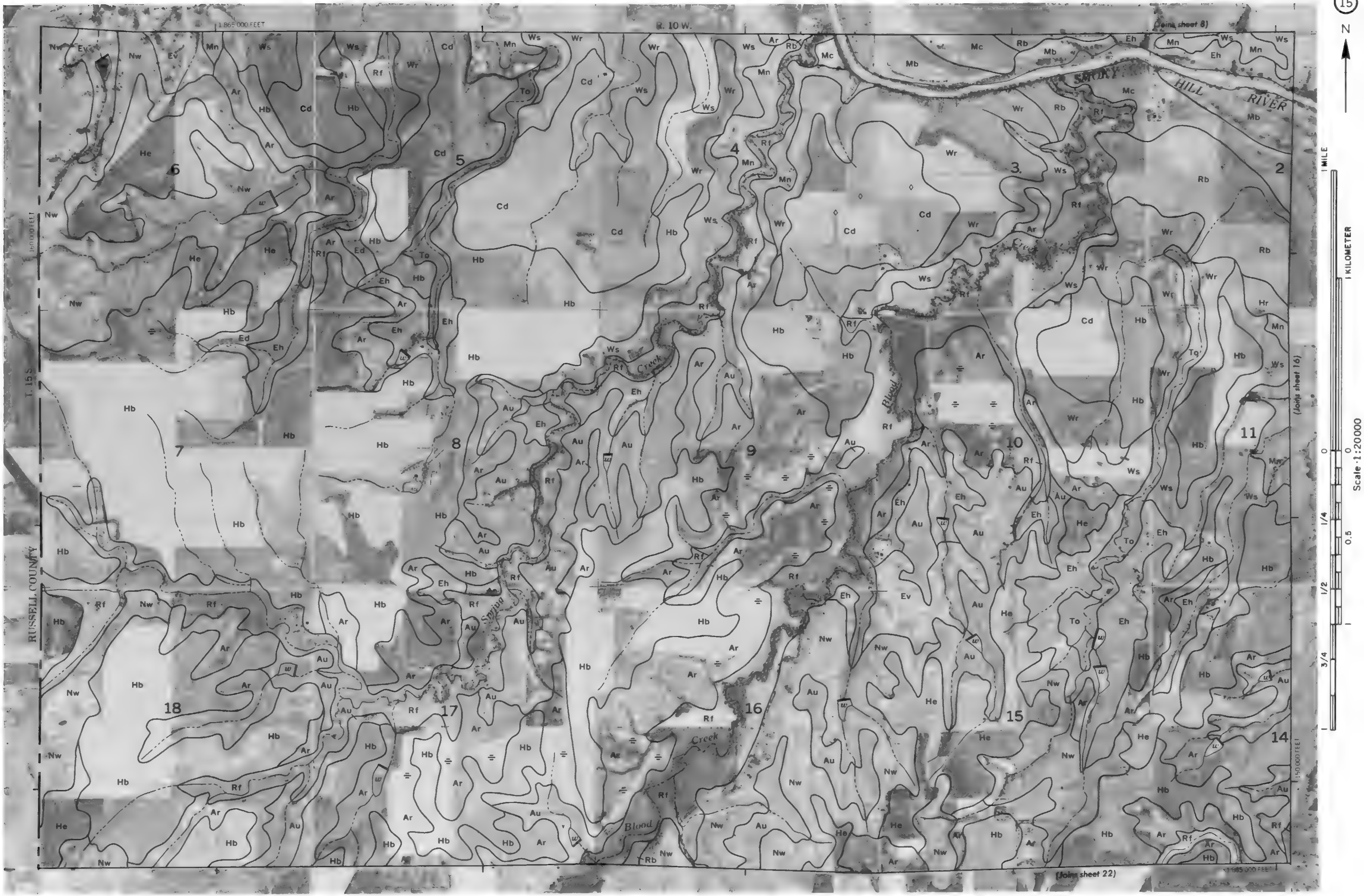
SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 15

15



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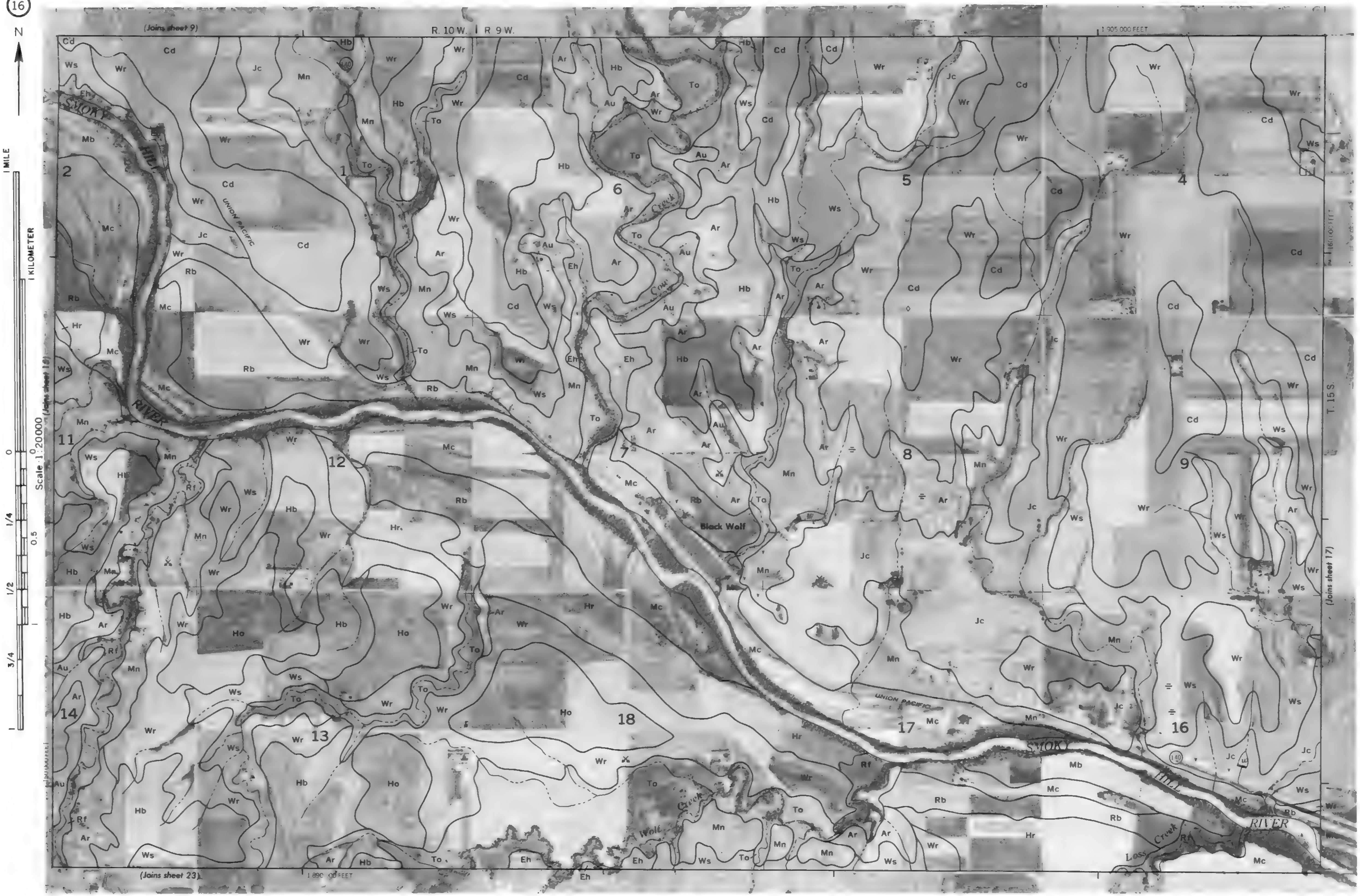
SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 16



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SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 17

17

N

1 MILE

1 KILOMETER

Scale 1:20000

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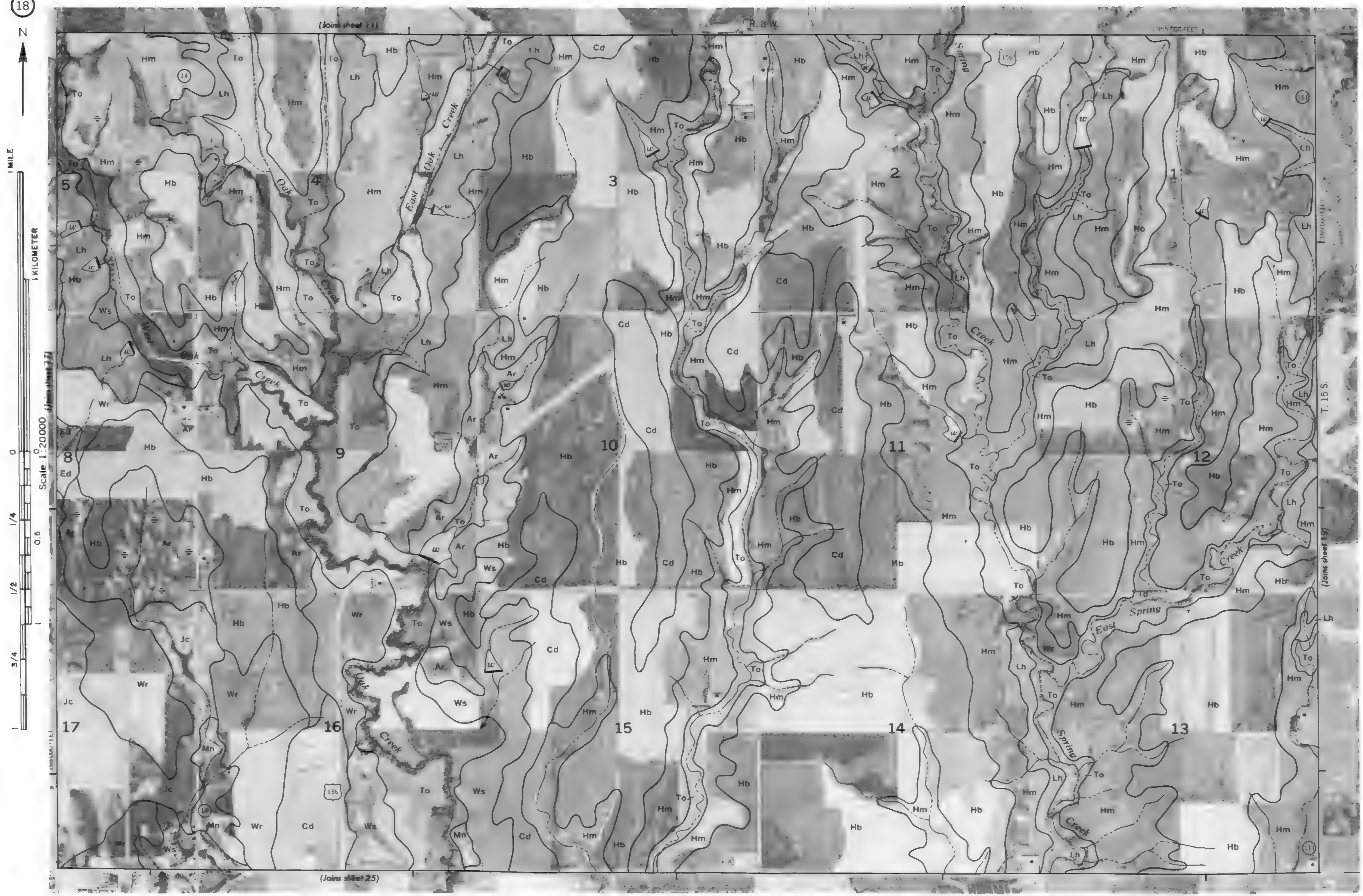
SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 18



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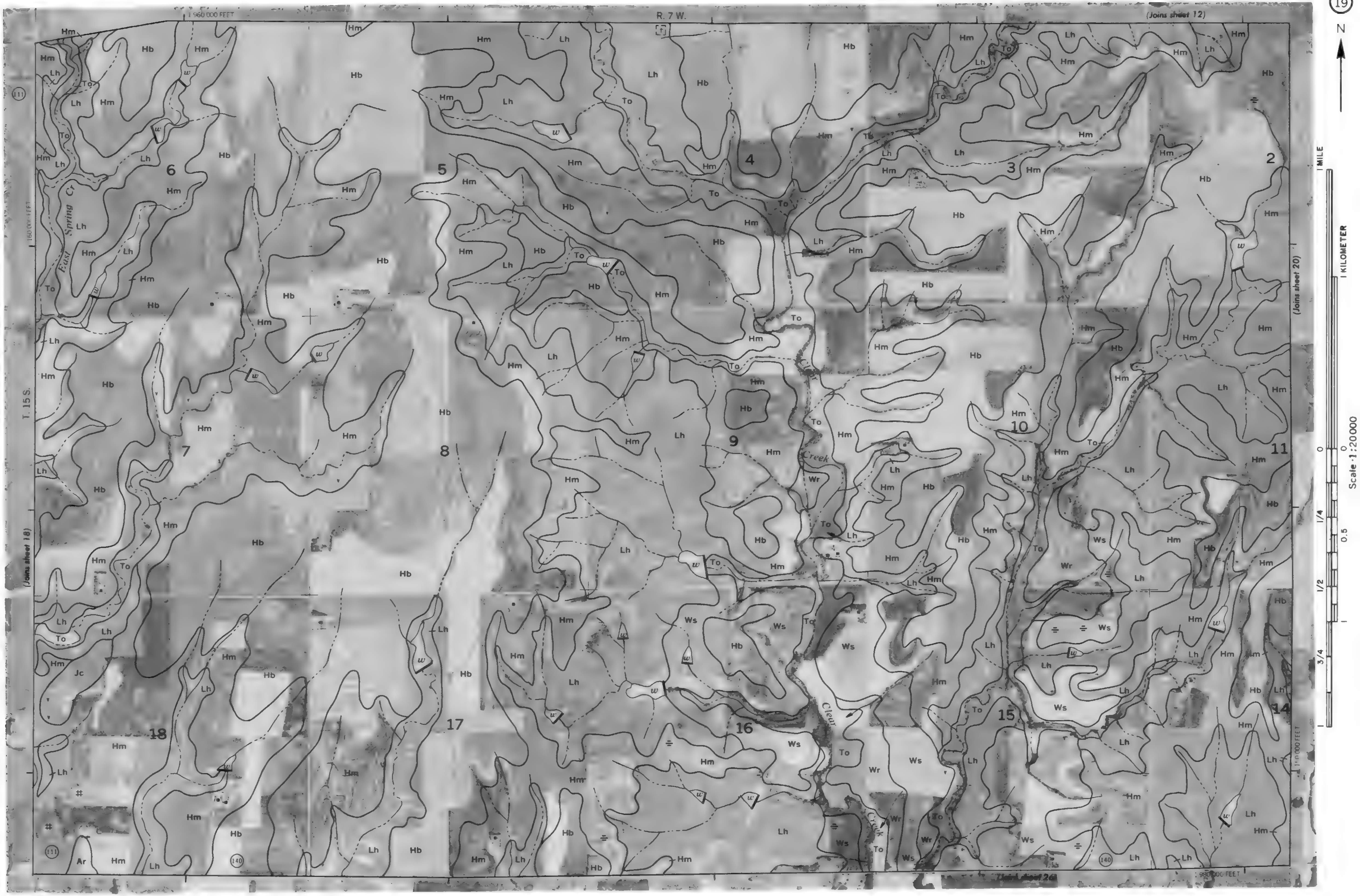
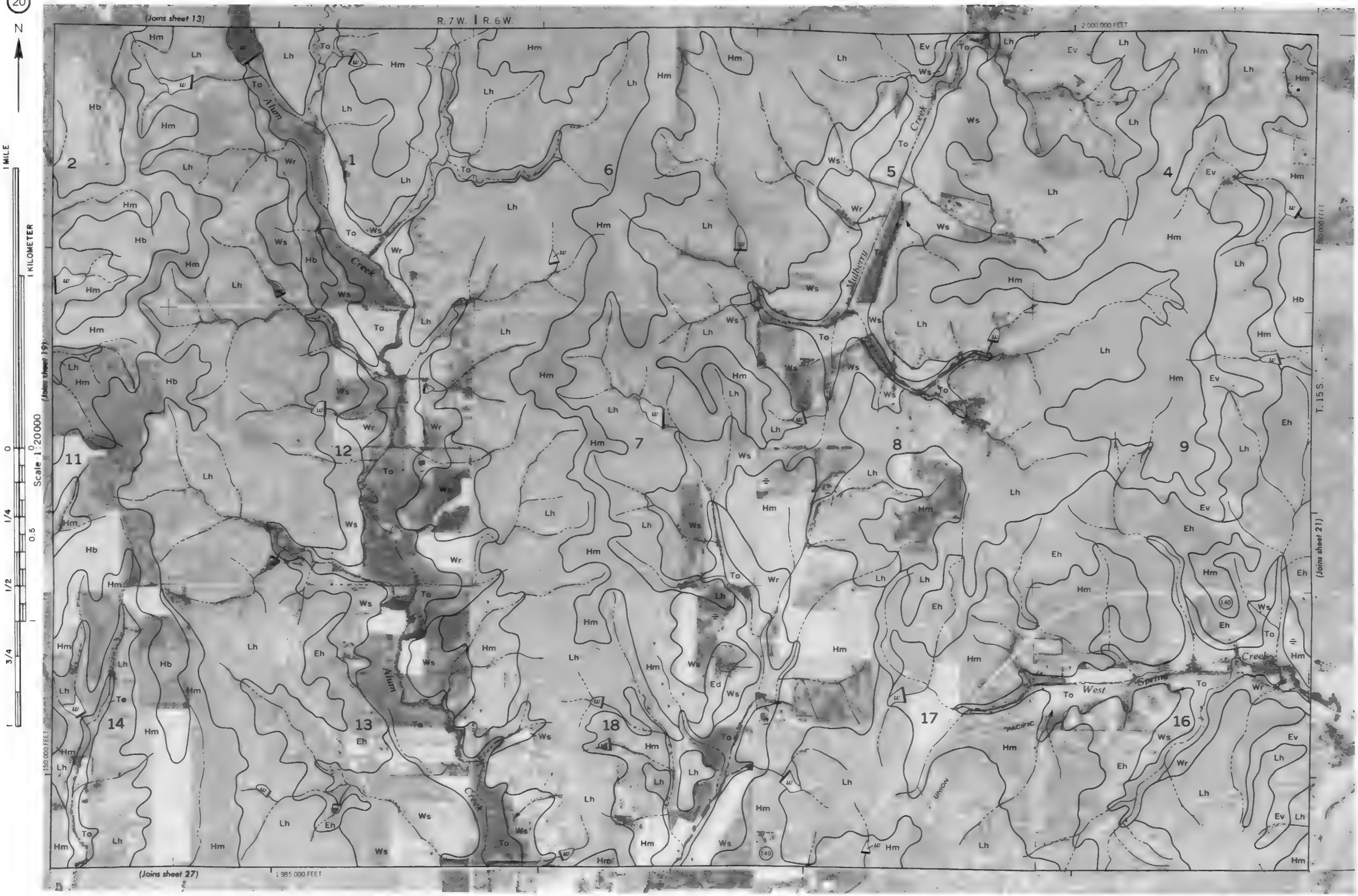


SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 20



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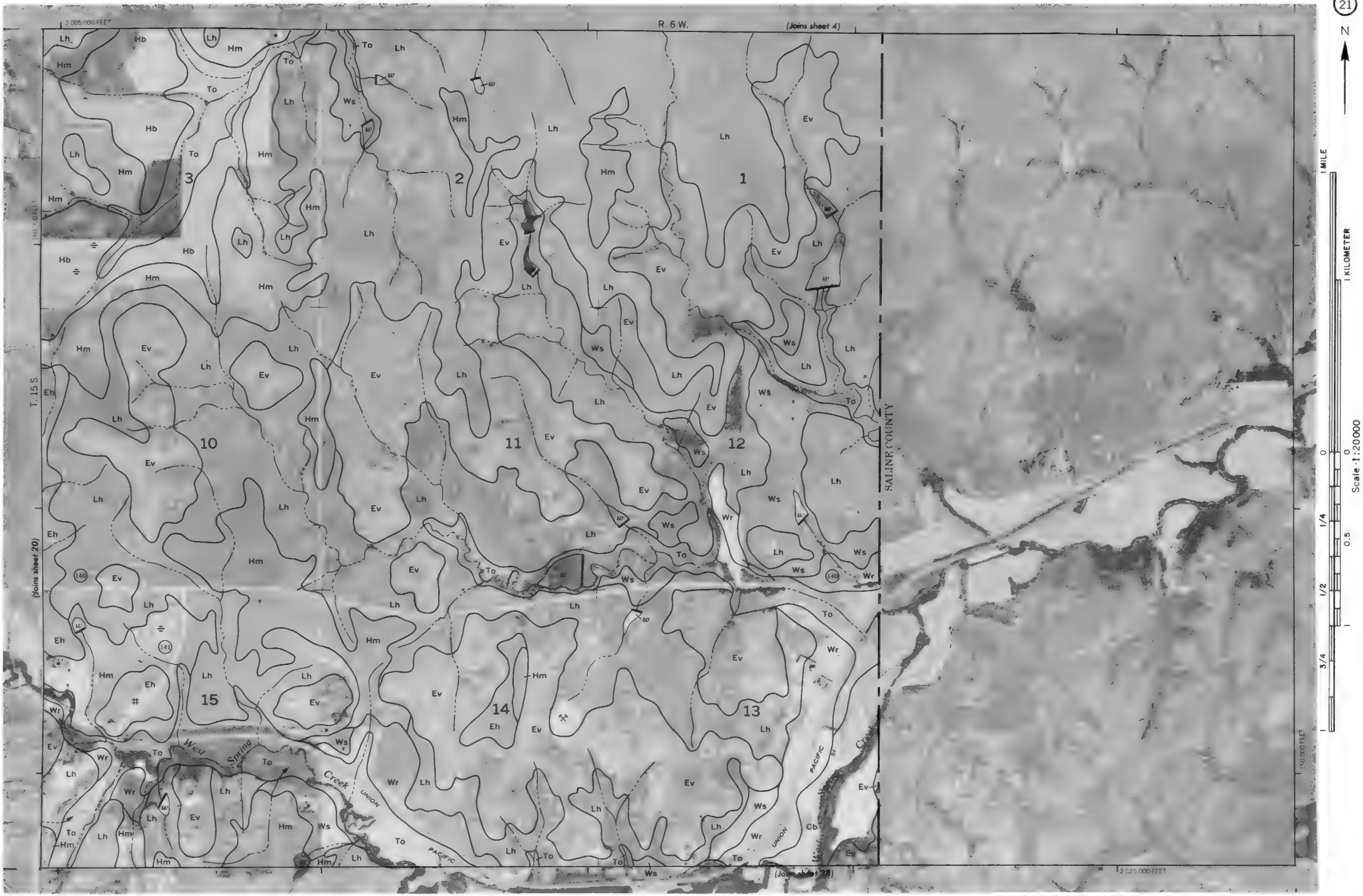

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SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 22

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24

N

1 MILE

1 KILOMETER

Scale 1:20000

0 1/4 1/2 3/4 1

0 0.5 1

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SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 25

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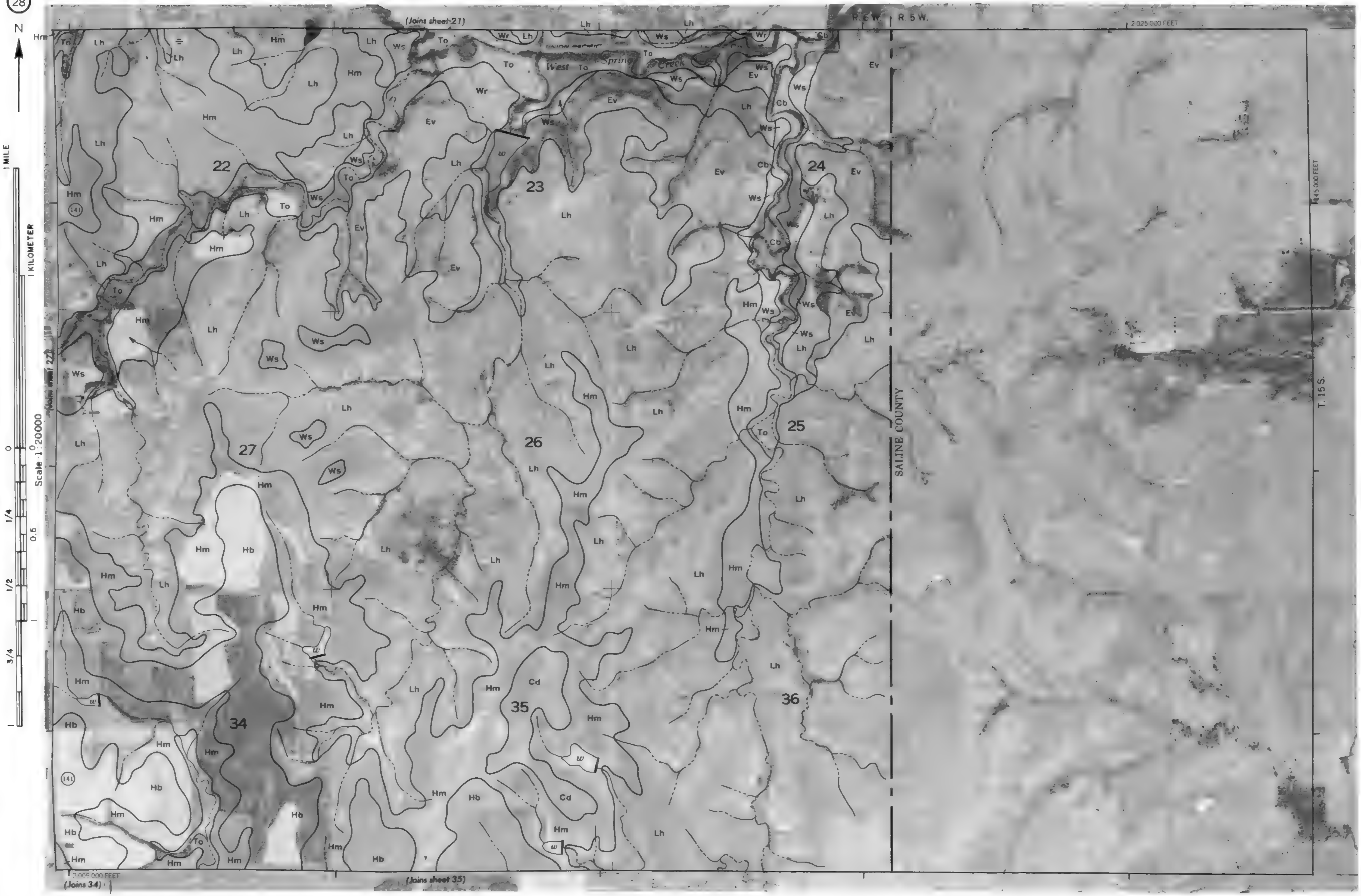
SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 28



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N

1 MILE

1 KILOMETER

Scale 1:20000

0 1/4 1/2 3/4 1

0 0.5 1

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SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 30

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SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 31

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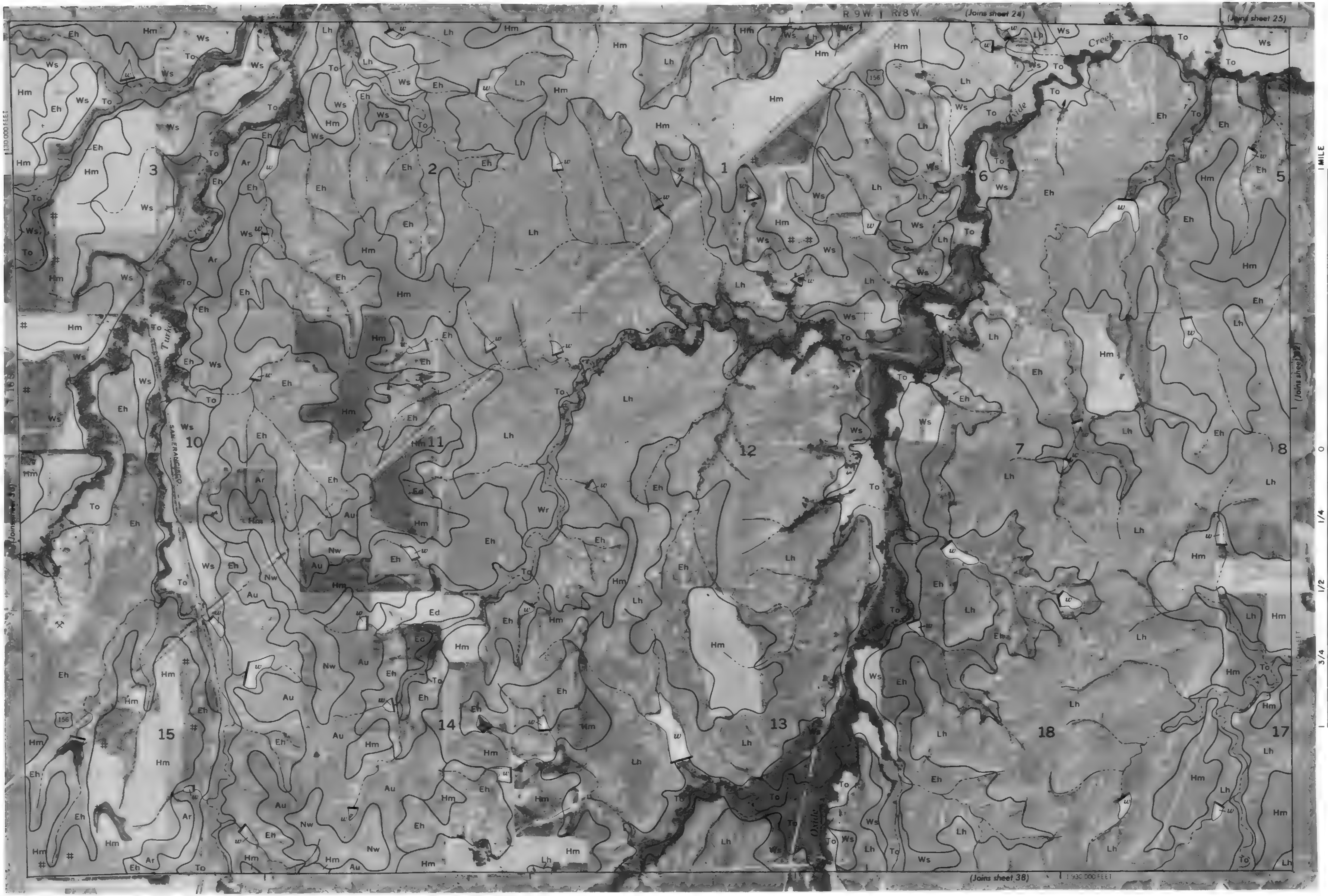

N

1 MILE

1 KILOMETER

Scale 1:20000

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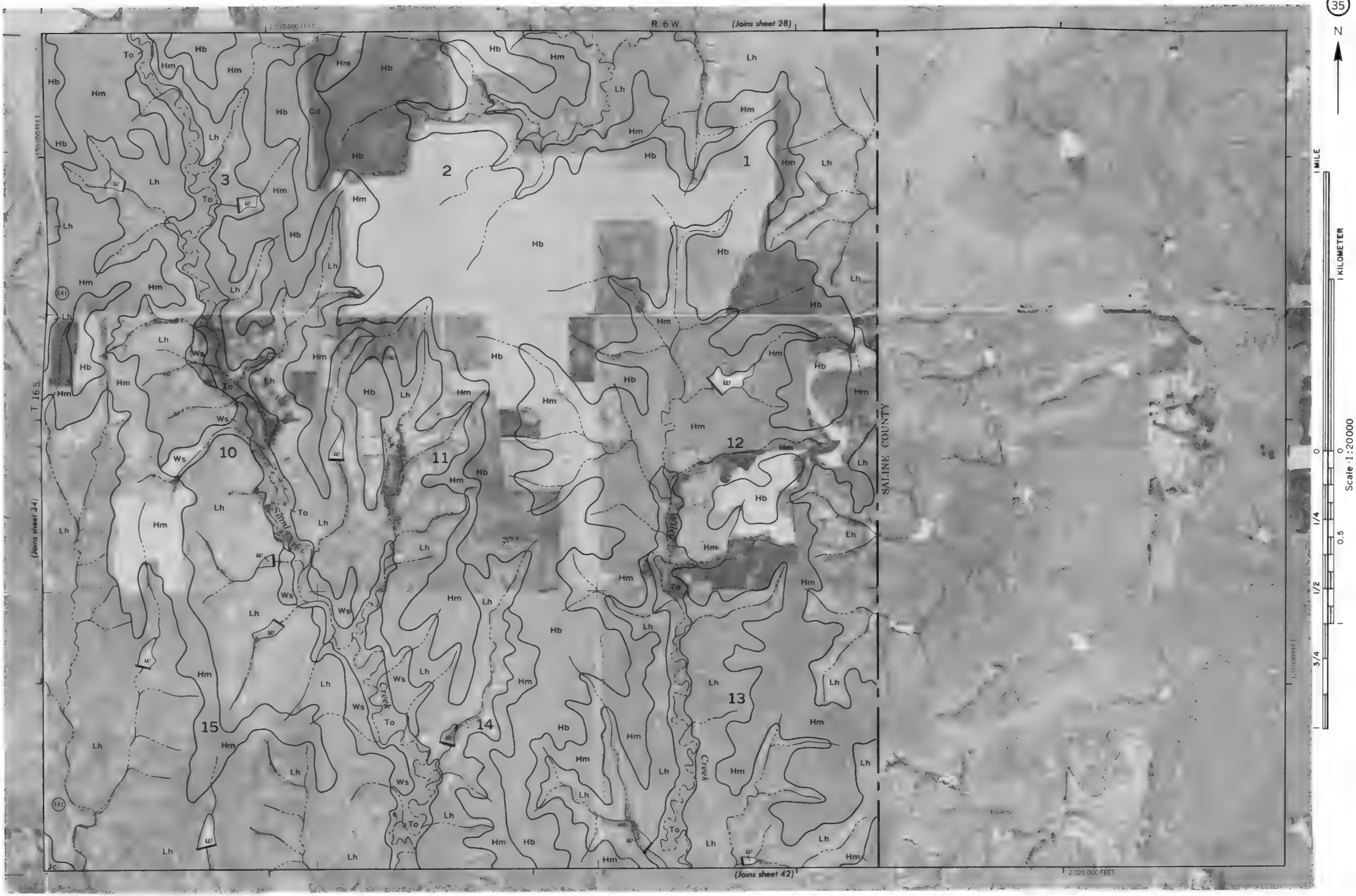

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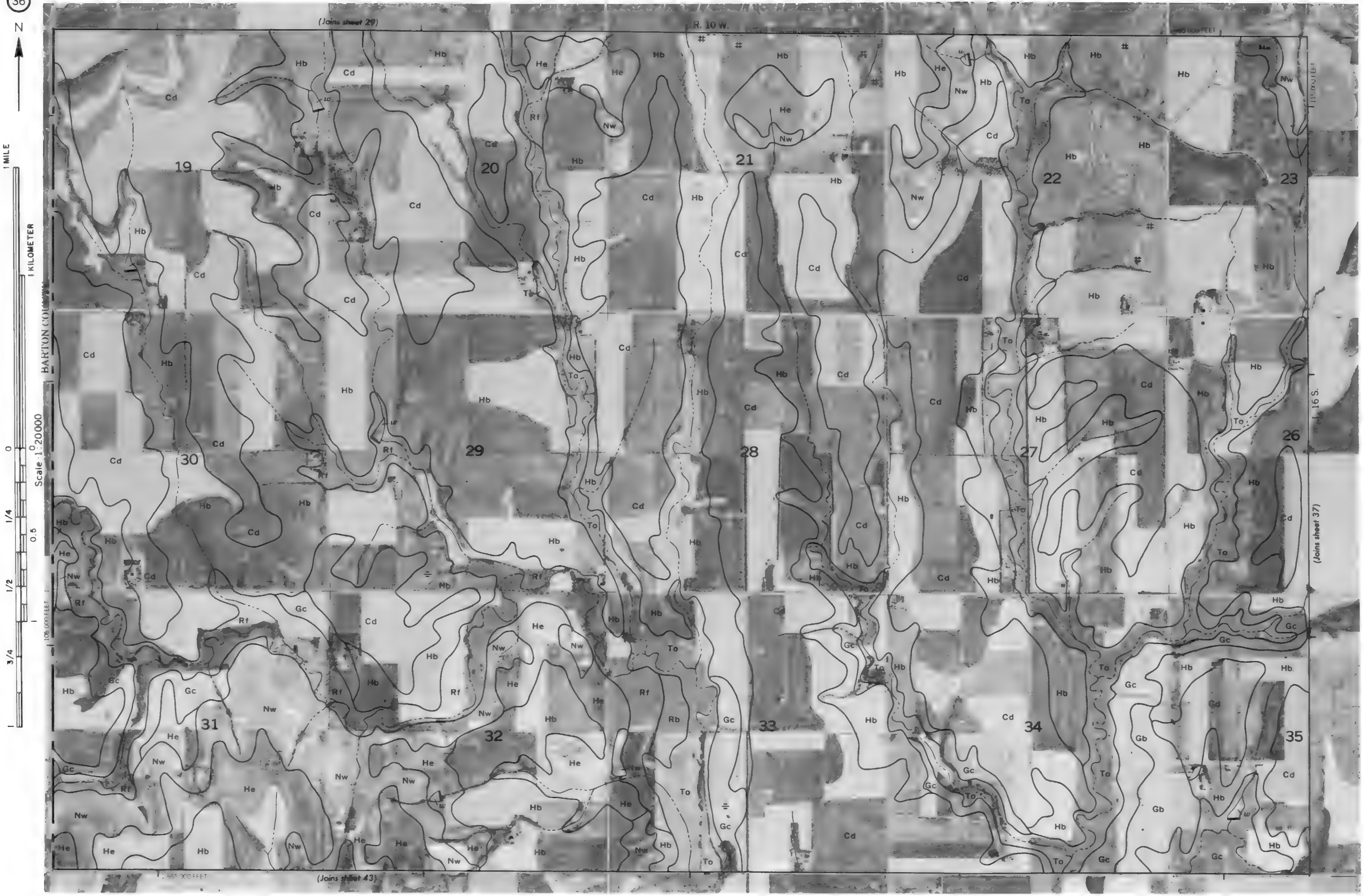

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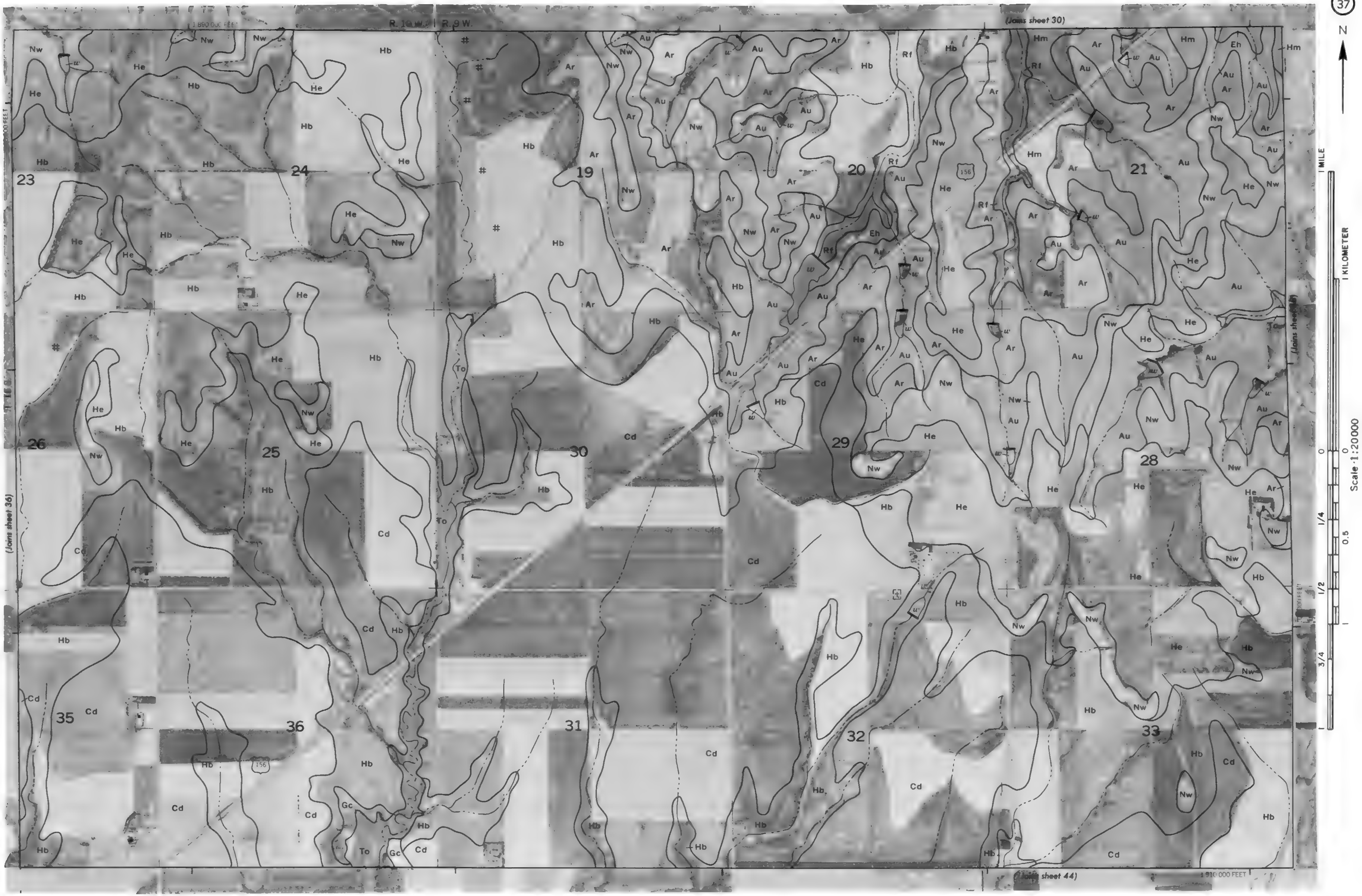

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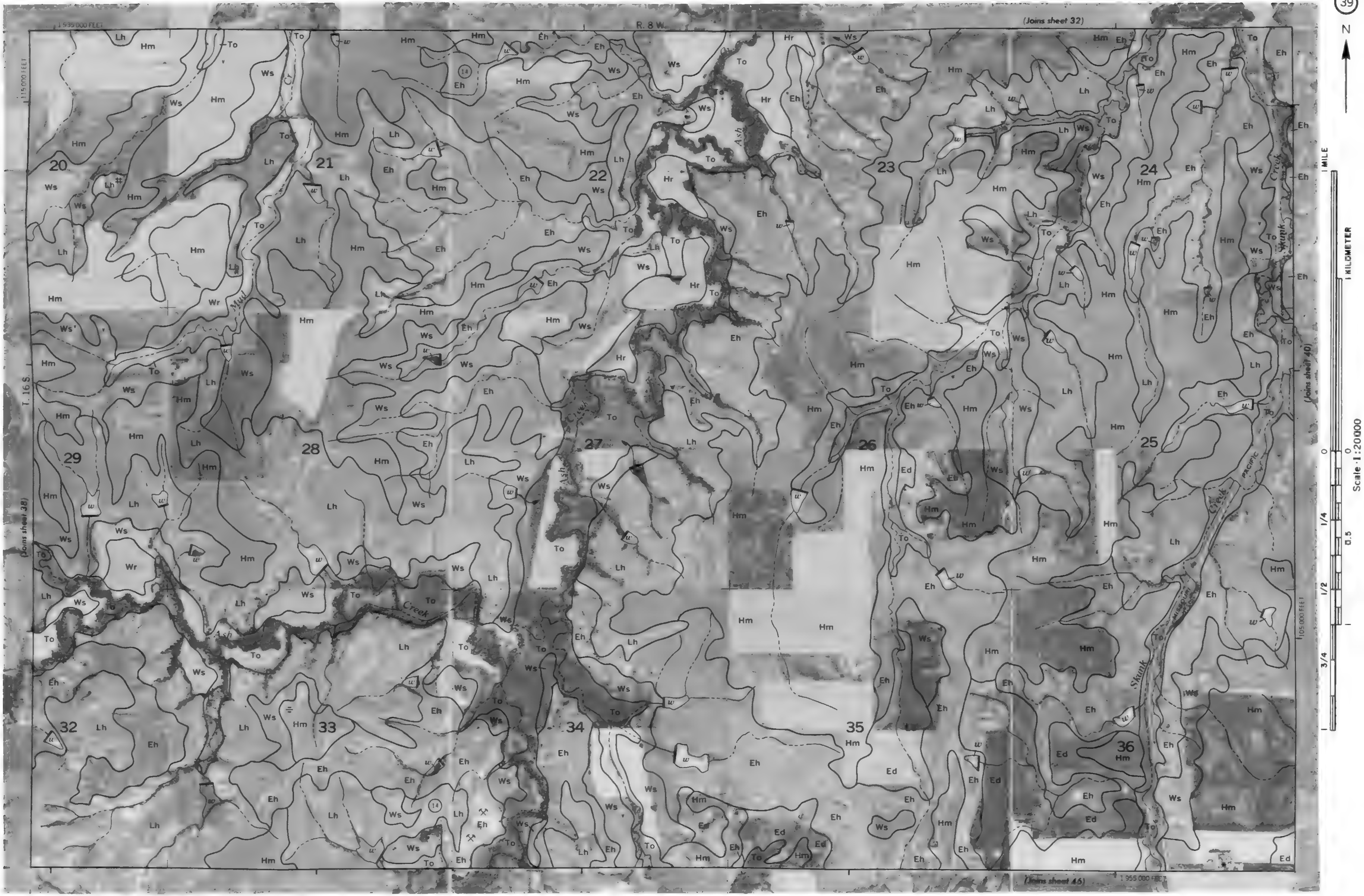
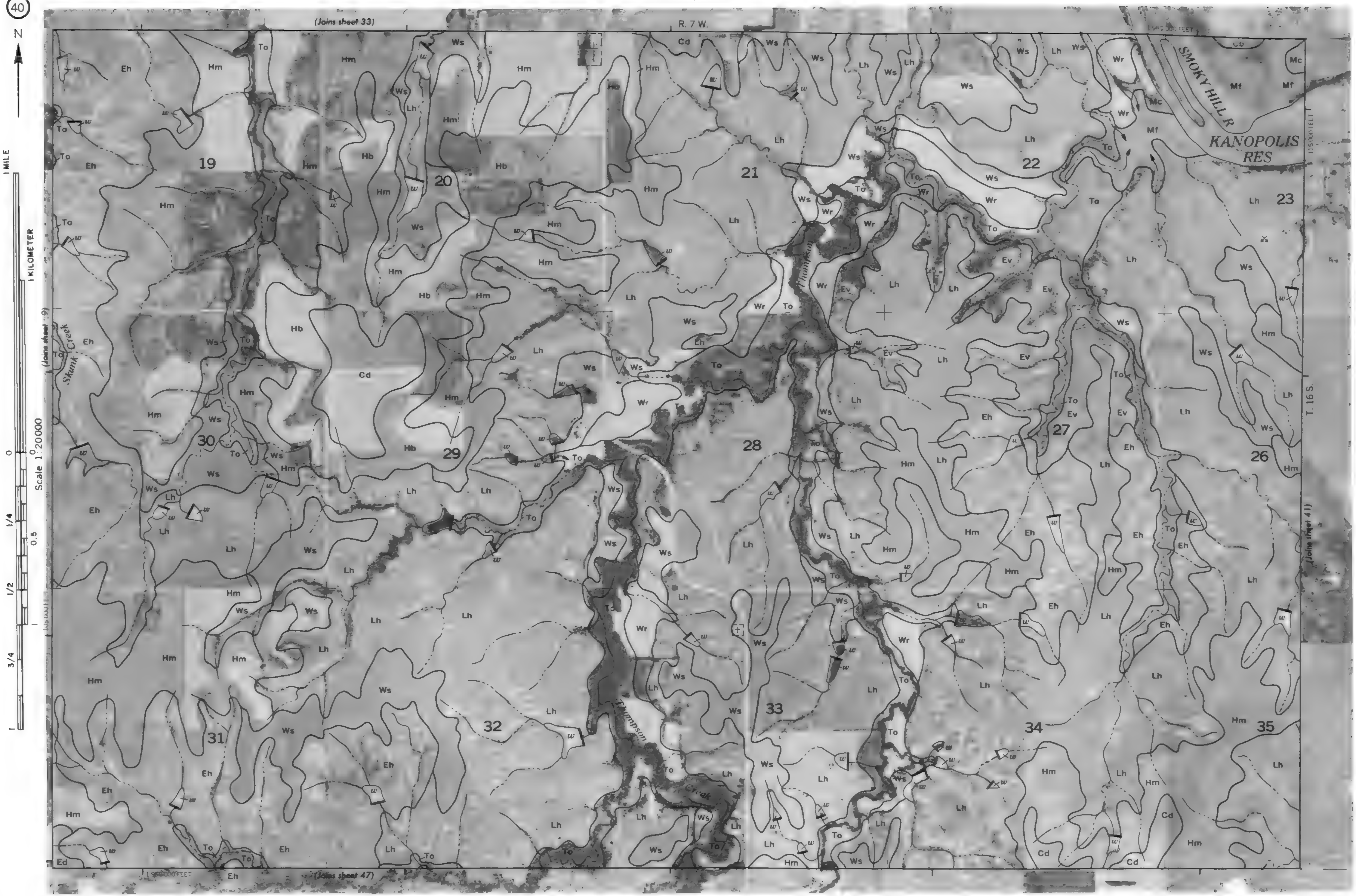


SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 40



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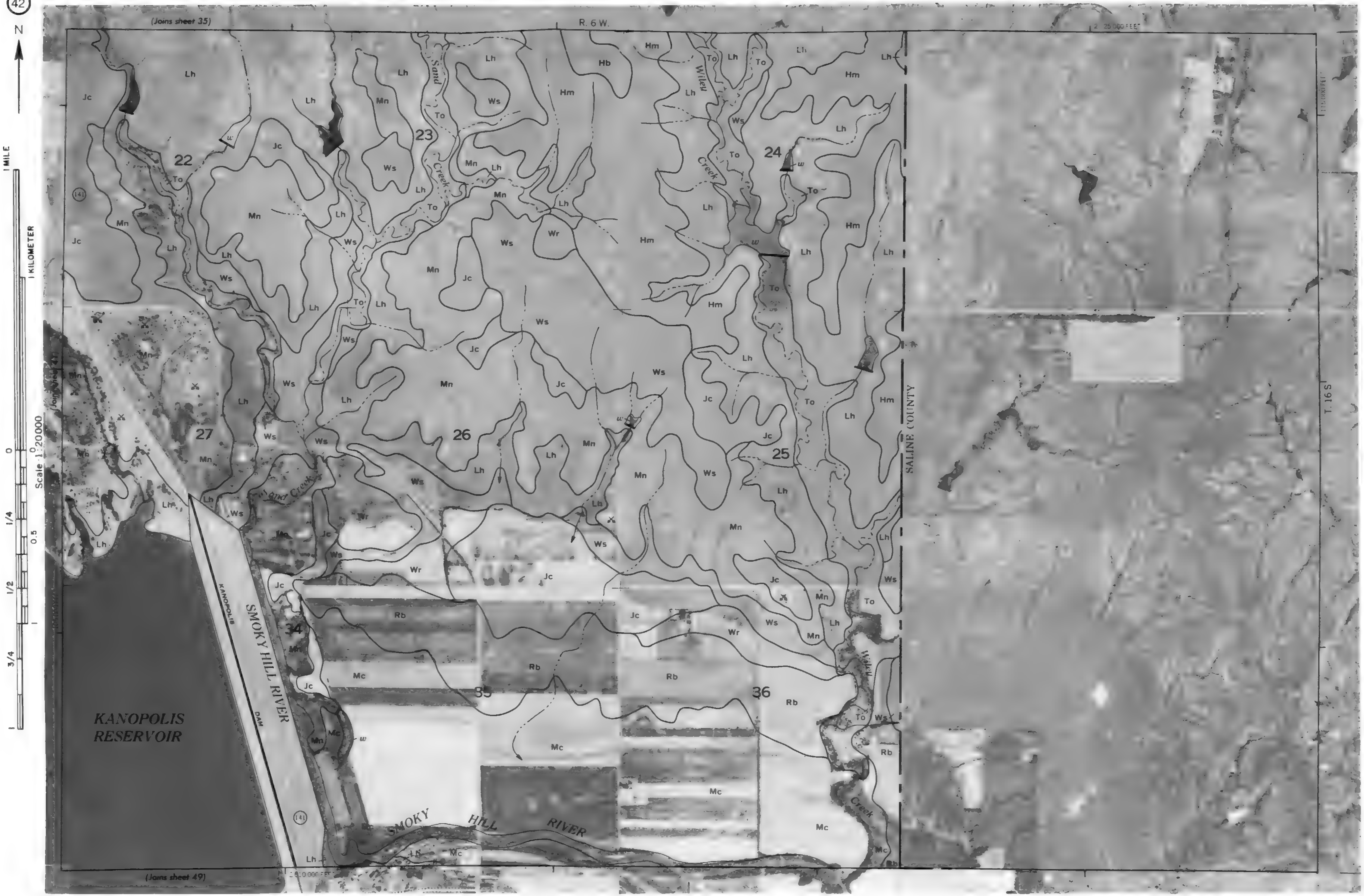
SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 42



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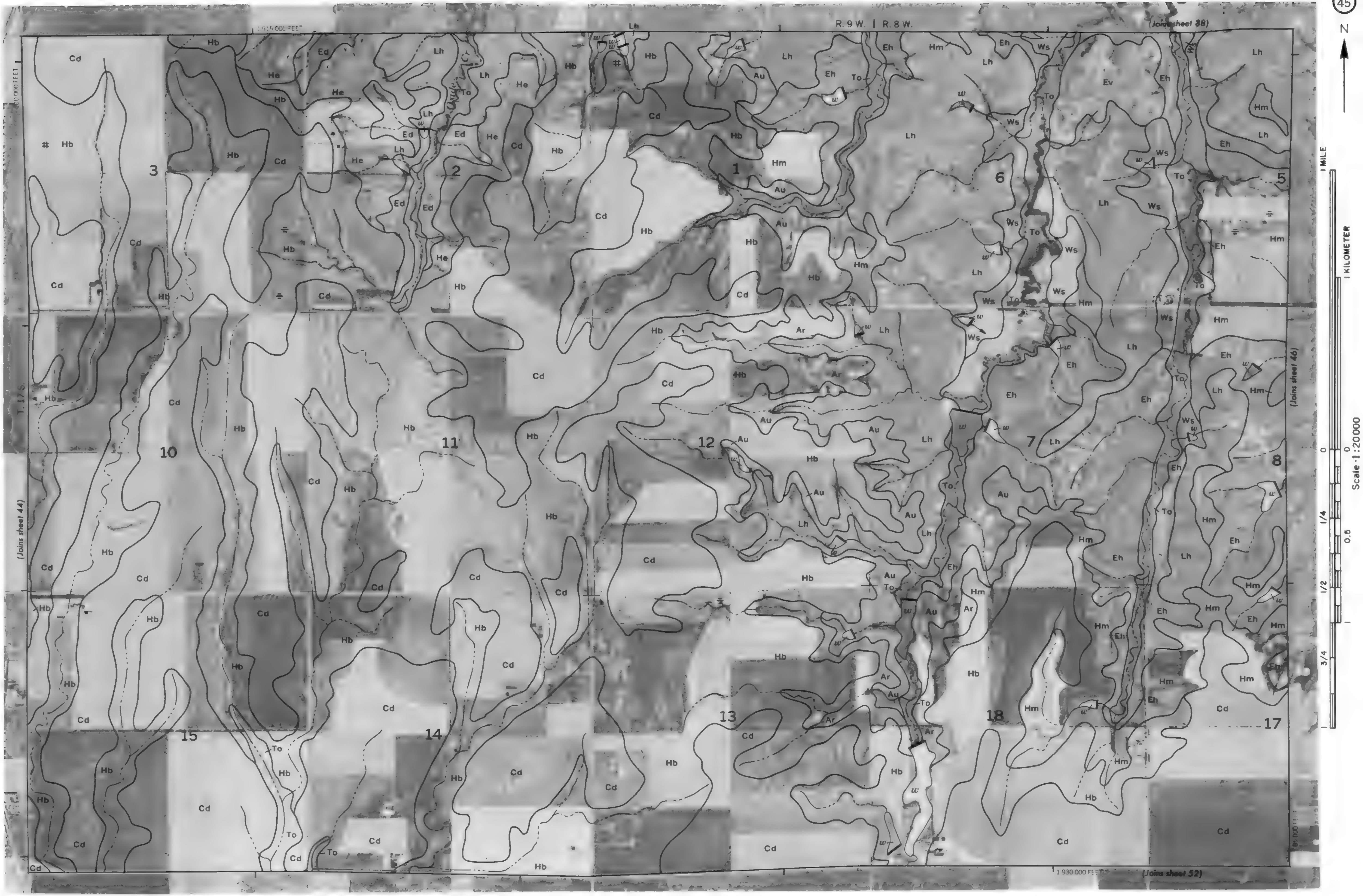
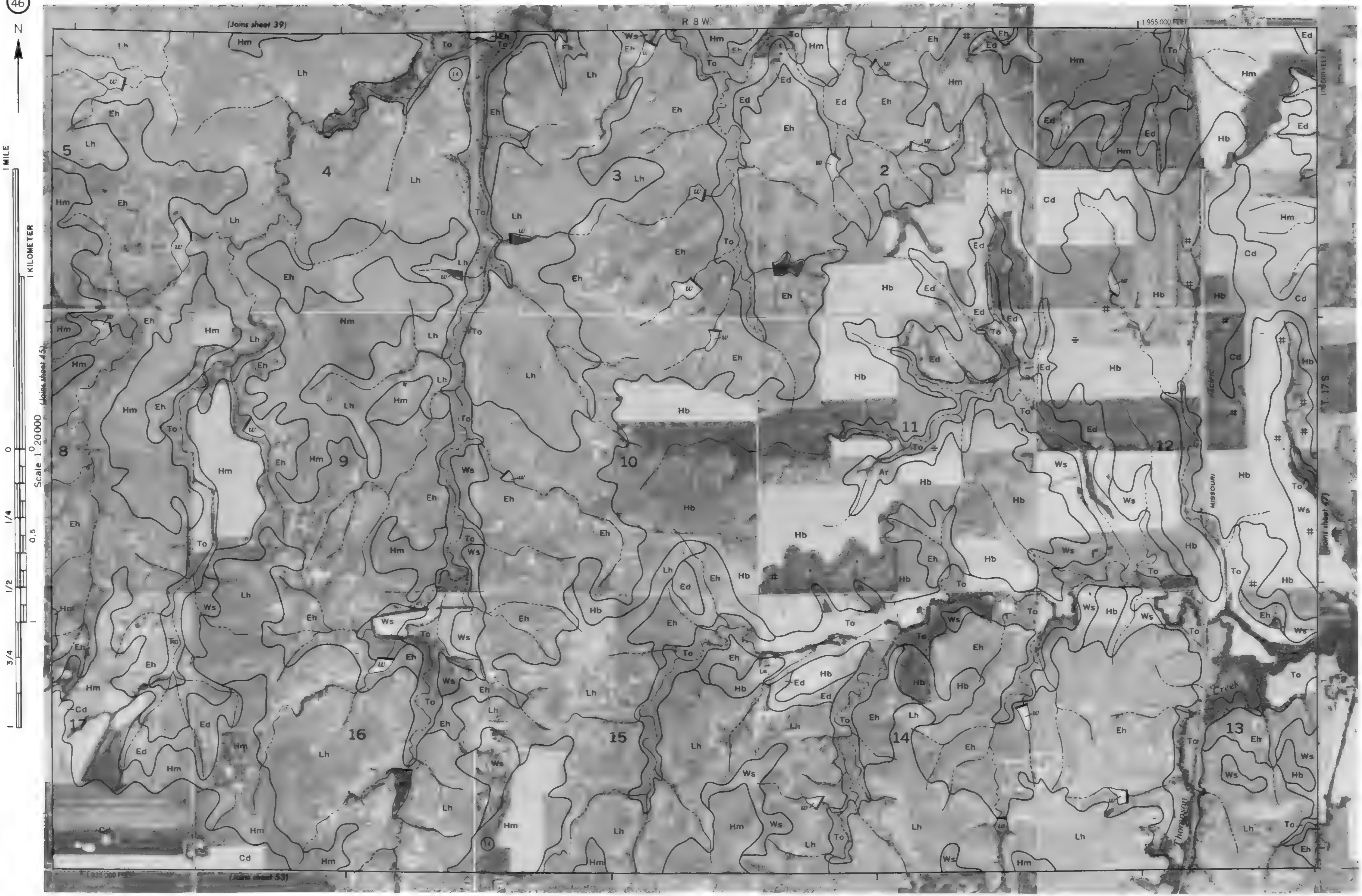


This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

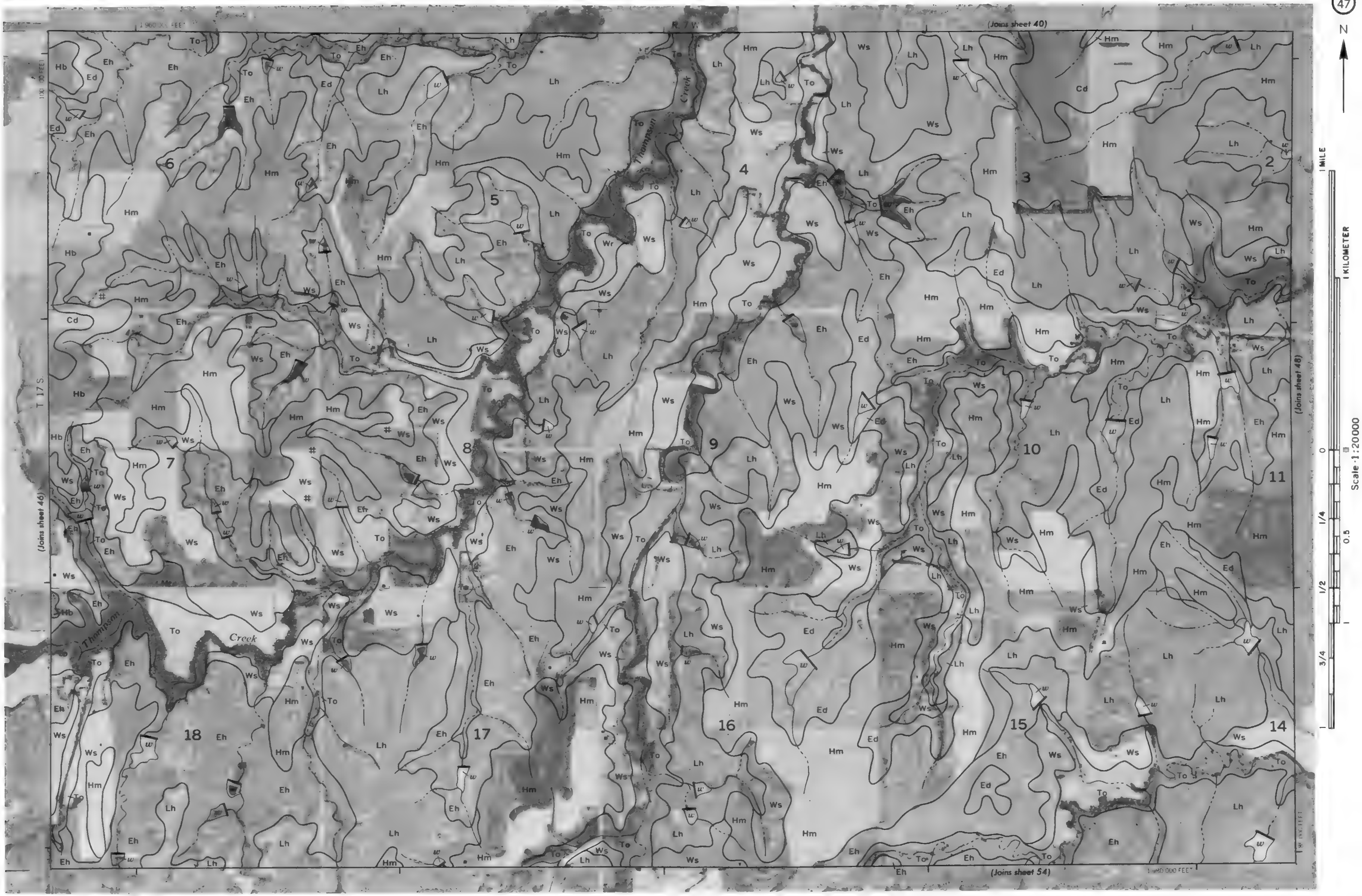
SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 46



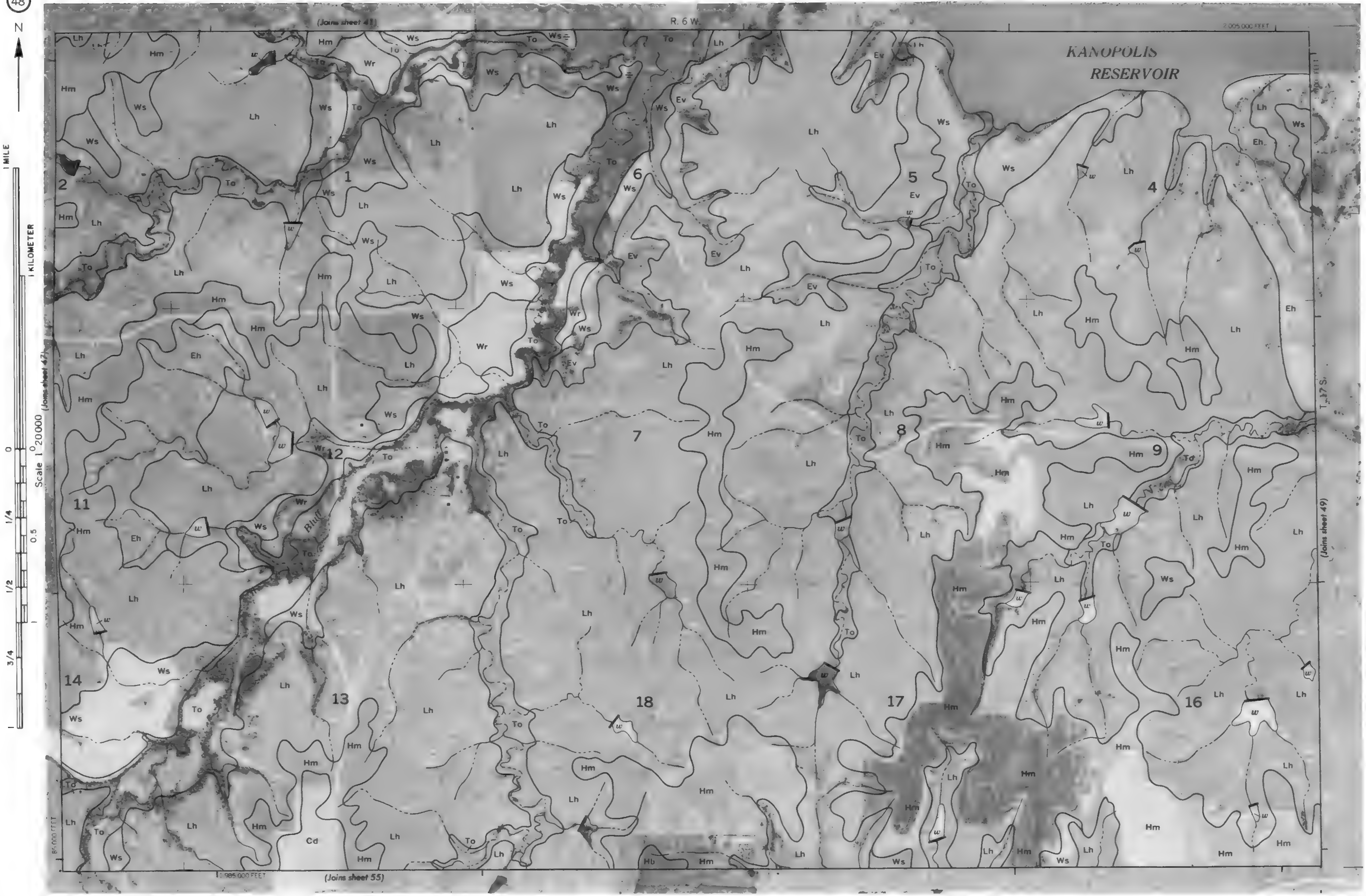
This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 47

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.



SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 48



This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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SOIL MAP OF ELLSWORTH COUNTY, KANSAS – SHEET NUMBER 49

49

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 50

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Coordinate grid ticks and land division corners, if shown, are approximately positioned.

N

1 MILE
0 1/4 1/2 3/4 1

1 KILOMETER
0 0.5 1

Scale 1:20000

SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 52

N

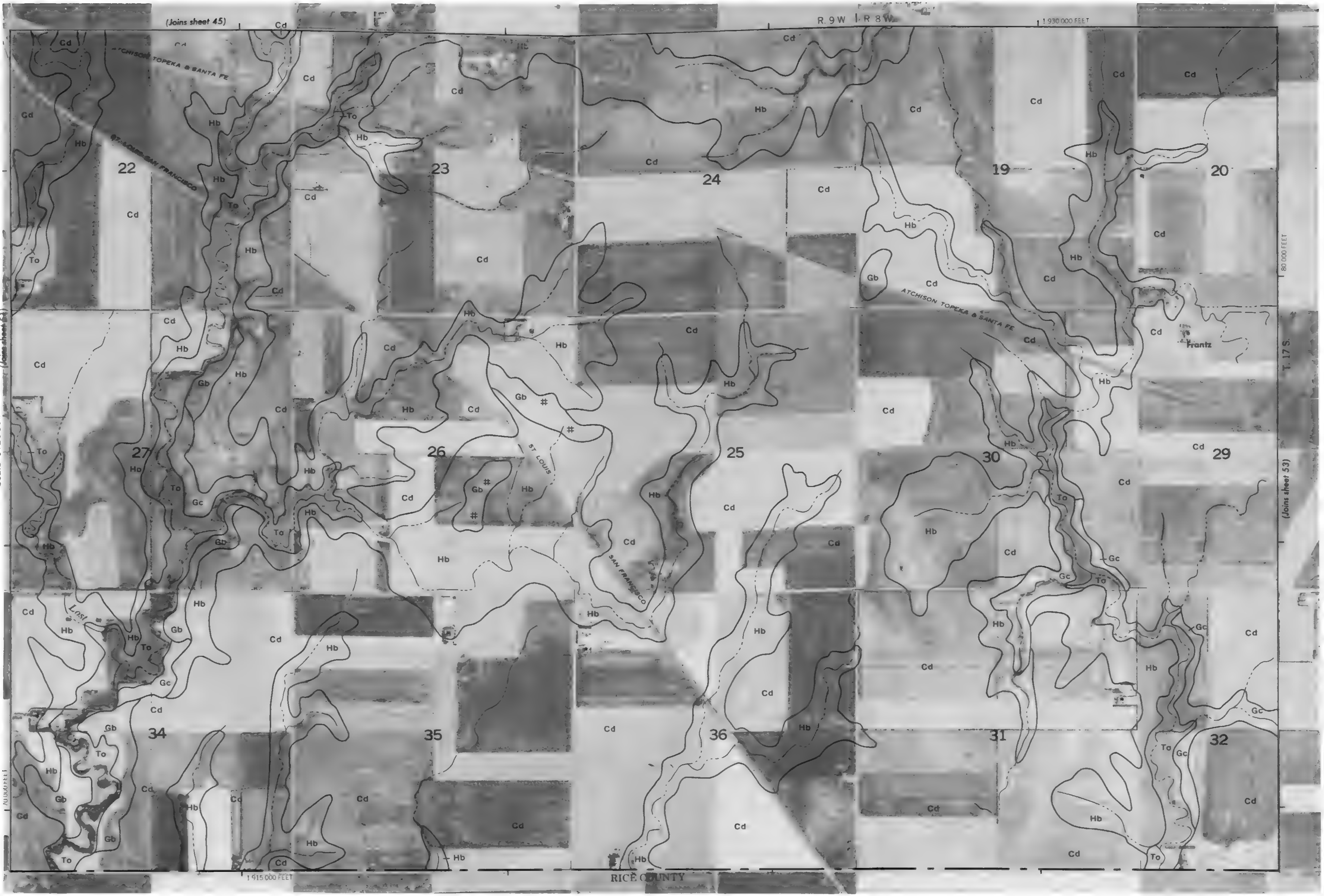
1 MILE

1 KILOMETER

Scale 1:20000

0 1/4 1/2 3/4 1

0 0.5 1



This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 53

This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
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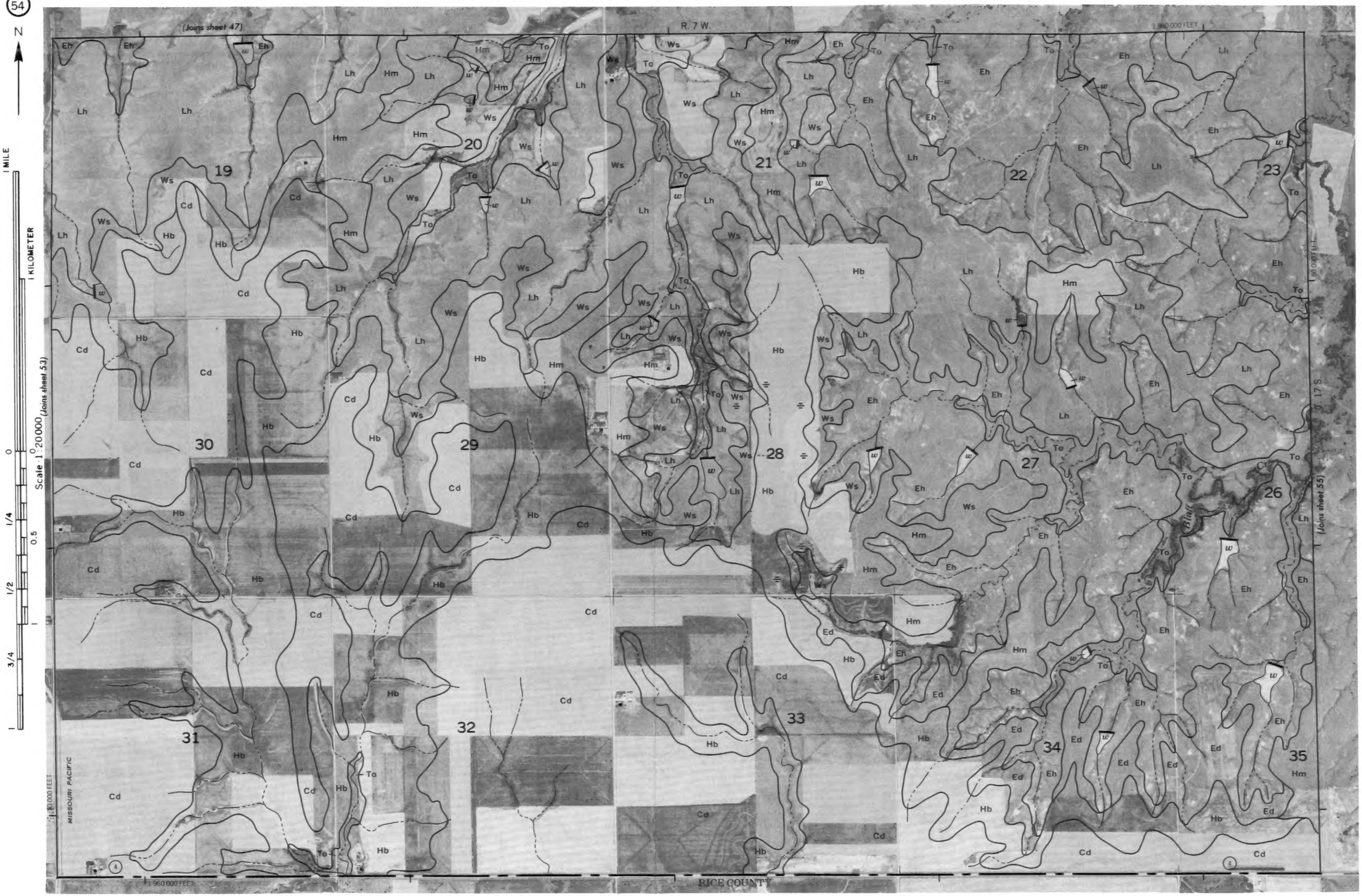
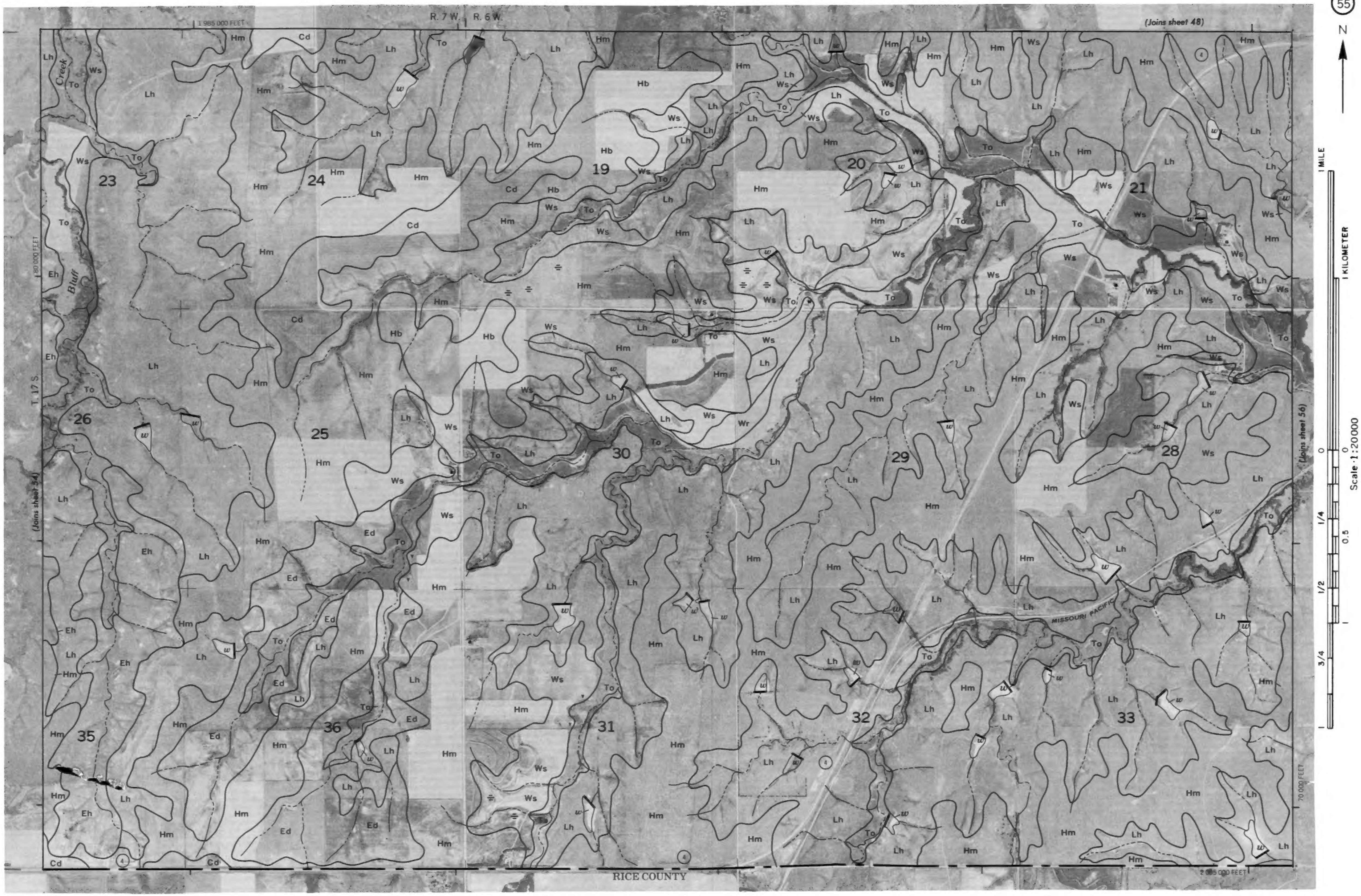
SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 54



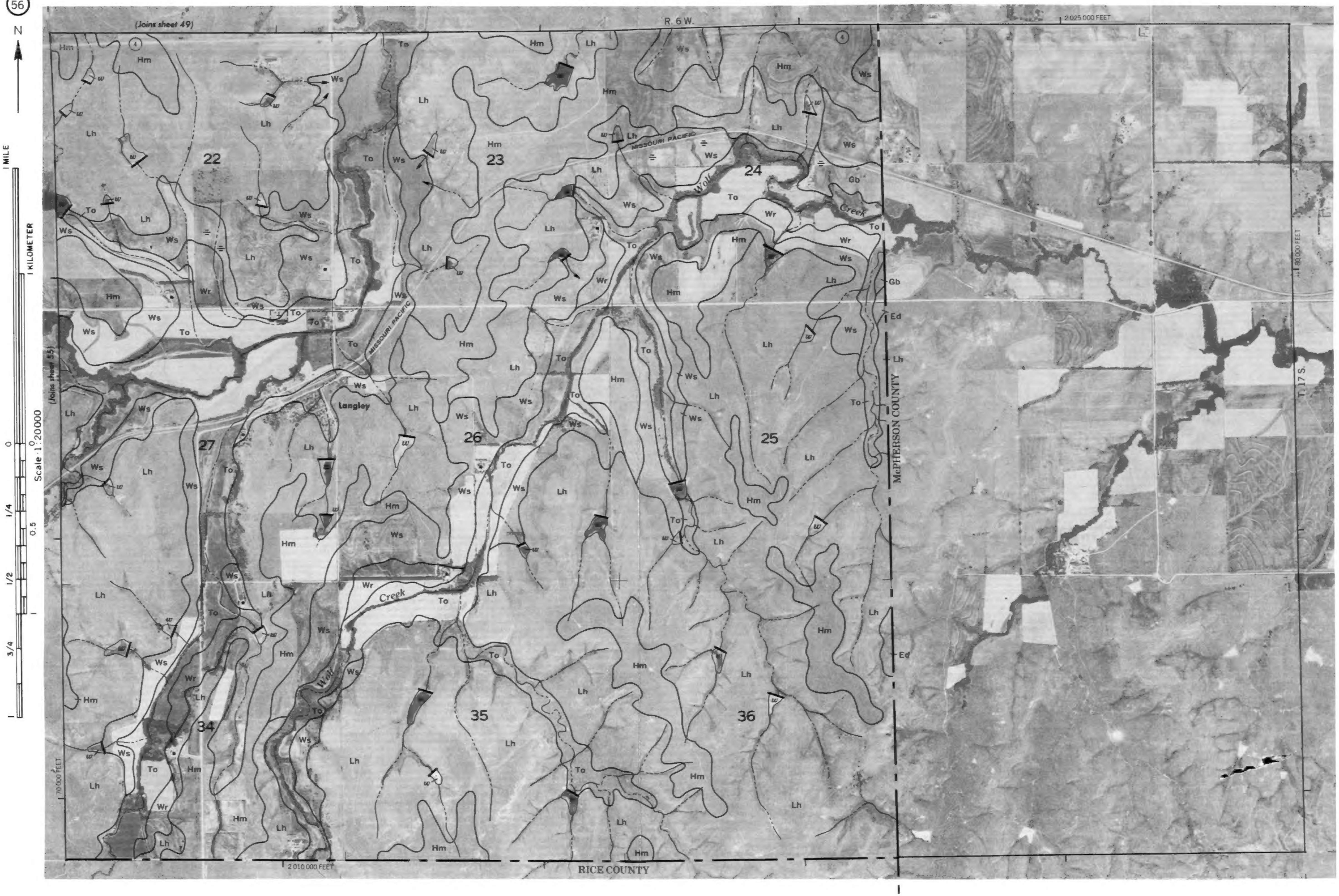
This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 55



This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL MAP OF ELLSWORTH COUNTY, KANSAS - SHEET NUMBER 56



This soil survey map is compiled on 1979 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.